CURRENT PESTICIDE USE IN ALBERTA

FISH AND WILDLIFE CONCERNS AND RECOMMENDATIONS

Alberta

RECREATION, PARKS
AND WILDLIFE

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ALBERTA RECREATION, PARKS AND WILDLIFE
FISH AND WILDLIFE DIVISION
WILDLIFE BRANCH

CURRENT PESTICIDE USE IN ALBERTA: FISH AND WILDLIFE CONCERNS AND RECOMMENDATIONS

Louise P. Horstman
December 21, 1976

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INTRODUCTION

Objectives of Report

There are two objectives of this report, both of them informational in nature.

The first is to provide Fish and Wildlife personnel with a look at the pesticides used in Alberta and the regulatory procedures governing their use. This information, gathered from numerous sources, has not been encountered elsewhere in the concise and integrated fashion that is attempted herein.

The second, and more important, objective is to present some of the ecological issues that are potentially applicable to the situation in Alberta with regard to pesticide usage patterns. Many agencies in the past few years have issued statements dealing with various aspects of pesticide usage; however, reviews of environmental research relevant to current usage patterns in western Canada are few. In many cases, reviews concerned with the pesticides of five or ten years ago are of little value in their ability to predict the results of present usage patterns. While there is still much work to be done in identifying the damage from past mistakes, those being presently made must also be recognized. This report describes briefly the research and monitoring work presently conducted by various agencies and examines the present input of Fish and Wildlife. Long-term goals for the Division are proposed, along with recommendations regarding some possible courses of action by which they might be achieved.

General Nature of Pesticides

Definition of "Pesticide"

In this report, as in much of the general literature on the subject, the term "pesticide" is used to denote any chemical intended to function as a herbicide, insecticide, miticide, vertebrate biocide, or vertebrate or invertebrate repellant. Plant growth regulators, due to the herbicidal function of some of the chemicals in this class, are also included in the term. Bacteriocides, constituting an extensive class by themselves, are not included.

Pesticide Nomenclature

A multiplicity of trade names (over 6,000) exists for the various formulations of the approximately 450-500 active chemical ingredients of the pesticides currently on the market. This necessitates reference to the active ingredients, rather than to the trade names, in the general literature. Since chemical nomenclature is often both cumbersome and nonstandardized, national and international committees have been established to allocate "common names" to these chemicals. The Canadian Committee on Common Names for Pest Control Chemicals, established in 1955, collaborates closely with the International Organization for Standardization Committee on Common Names for Pesticides. Although the designated common names are widely shared by many countries, more than one common name is still in use in many cases. In this report, the common names of chemicals are not capitalized. Trade names are capitalized and alternative common names are given in parentheses.

CHEMICAL CLASSIFICATION OF PESTICIDES AND PRIMARY MODES OF ACTION*†

I. Insecticides and miticides

A. Inorganic (containing metal but not carbon)

- mercury
- boron
- arsenic (calcium and lead arsenate)
- selenium
- fluoride (sodium fluoride)
- paris green

B. Organic

1. Chlorinated hydrocarbons

    a. DDT and related compounds (These probably bind to the nerve membrane, thereby interfering with ion influx and efflux).

    - DDT
    - methoxychlor
    - dicofol (Kelthane)

    b. Cyclodienes (Exert influence on nerve in as yet undetermined way)

    - aldrin, dieldrin
    - heptachlor
    - endosulfan (Thiodan)
    - chlordane
    - toxaphene

    c. Hexachlorocyclohexanes

    - lindane
    - BHC

2. Organophosphates (organic compounds containing phosphorus) (Inhibitors of acetylcholinesterase, the enzyme important in control of nerve transmission.)

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* Examples given under headings do not constitute a complete listing.

† Modes of action summarized from O'Brien (1967) and Corbett (1974).

azinophos-methyl (Guthion)
carbophenothion (Trithion)
coumaphos
demeton (Systox)
diazinon
dichlorvos (Vapona)
dimethoate (Cygon)
ethion
fensulfothion
malathion
ronnel
trichlorfon (Dylox)
phosdrin
TEPP
parathion

3. Carbamates (Inhibit acetylocholinesterase enzymes by acting as substrates)

propoxur (Baygon)
carbaryl (Sevin)
carbofuran (Furadan)
dimetilan (Snip)
methomyl (Lannate)
zectran

4. Botanicals

pyrethrine
rotenone
nicotene

II. Herbicides

A. Inorganic

sodium borate
sodium chlorate

B. Organic

1. Chlorinated Aliphatic Acids (Mode of action unknown)

dalapon
TCA

2. Benzoic acids (Act as persistent auxins [hormones] in plant, thereby interfering with natural hormonal levels)

chloramben
dicamba
picloram
trichlorbenzoate (2,3,6-TBA)

3. Bipyridiliums (Responsible for formation of biologically damaging free radicals, which probably destroy cell membranes)

   diquat
   paraquat
   morfamquat

4. Carbamates (Thought to disrupt mitotic spindle formation during cell division)

   barban (Carbyne)
   asulam

5. Dinitroanilines (Inhibit cell division by inducing chromosomal and nuclear aberrations)

   trifluralin (Treflan)

6. Hydroxybenzonitriles (Inhibit electron transport of photosynthetic and mitochondrial processes)

   bromoxynil (Buctril)
   ioxynil

7. Phenoxyalkanoic acids (Interfere with regulatory hormonal levels in the plant)

   2,4-D
   MCPA
   2,4,5-T
   mecoprop

8. Acylanilides (Modes of action unknown)

   propanil

9. Thiocarbamates (Inhibit production of wax by plant)

   diallate (Avadex)
   triallate (Avadex BW)
   EPTC
   pebulate

10. Triazine derivatives (Probably cause plant death by a combination of damage to the photosynthetic machinery and hence starvation)

    simazine
    atrazine
    propetryne
    ametryne

11. Ureas (Mechanism probably same as in #10 above)

    linuron
    diruon
    monuron
    chloroxuron
    tebuthiuron

12. Modified uracils (Lethal to meristematic tissue; mode of action undetermined.)

    bromacil
    maleic hydrazide

13. Ethers (Inhibit photosynthesis)

    nitrofen

111. Fungicides

A. Inorganic

copper (copper sulfate)
mercury (mercurous or mercuric chloride)
(Combine with sulfur - containing groups on proteins)
sulfur
halogens (calcium and sodium hypochlorite)

B. Organic

1. Dithiocarbamates (Breakdown product responsible for their undetermined mode of action)

   thiram
   maneb
   ziram

2. Heterocyclic nitrogen (Thought to react with sulfur-containing molecules in the cell)

   captan
   folpet
   dichlofuanid

3. Quinones (Effect may be due to reaction with thiol, amino groups or enzymes)

   chloranil
   dichlone

4. Dinitrophenols

   binapacryl

dinocap
dinocton

5. Halogenated and nitrated aromatics

chloramine

6. Organometallics

a. Organic mercurials

b. Trisubstituted tins (Affect undetermined site in mitochondria)

fentin acetate
bis oxide

IV. Vertebrate Biocides

A. Inorganic

Zinc phosphide (Releases the nerve gas, phosphine)

B. Organic

1. Botanicals

rotenone (Affects electron transport in mitochondria)
strychnine sulphate
silmurine (Red squill)

2. Calcium cyanide

3. Sodium fluoroacetate (Compound 1080) (Inhibits TCA cycle enzyme)

4. Nitrophenyl ureas

vacor

5. Pyridines

4 - aminopyridine (Avitrol)

6. Organophosphates (Inhibits acetylcholinesterase enzyme important in nerve transmission)

mevinphos
fenthion (Baytex)

7. Complex heterocyclic compounds (These counter the effects of Vitamin K, producing gradual decrease in prothrombin levels in the blood and internal hemorrhaging)

chlorophacinone (Rozol)
diphacin (Ramik)
coumachlor (Ratilan)
warfarin

FEDERAL TESTING, EVALUATION AND REGISTRATION OF PESTICIDES

Federal Legislation Dealing with Pesticides

The following federal acts have potential bearing on the control of pests and regulation of agricultural chemicals:

(1) Pest Control Products Act (1972) - provides for control of the registration and sale of pesticides by Minister of Agriculture.
(2) Food and Drug Act - regulation of contamination in food, etc.
(3) Feeds Act - regulation of contamination in feeds, etc.
(4) Canada Water Act
(5) Migratory Birds Convention Act - prohibits harmful substances in water used by migratory birds.
(6) Fisheries Act - prohibits harmful substances in water frequented by fish.
(7) Pesticide Residue Compensation Act - provides compensation for loss of sale due to contamination of a product through no fault of the farmer
(8) Hazardous Substances Act - regulation of sale and use of hazardous materials.
(9) Environmental Contaminants Act (1976) - allows for investigation of toxic chemicals entering the environment by Ministers of National Health and Welfare and Environment.

The Pest Control Products Act (P.C.P. Act)

The federal regulations controlling the production and sale of pesticides in Canada are carried out mainly under the authority of the Pest Control Products Act. This legislation, administered by the Control Products Section of the Plant Products Division, Canada Department of Agriculture, gives the federal government the authority to regulate the manufacture, storage, display, distribution and use of pest control products, including: insecticides, acaricides, molluscicides, fungicides, algicide , herbicides, nematocides, rodenticides, piscicides, avicides, insect repellents, animal repellents, pest repellents, insect attractants, plant growth regulants, microbial control agents (slimicides, bacteriostatic agents, sanitizers), disinfectants (sterilizers, germicides, bactericides, sporocides, viricides), and devices for pest control.

The P.C.P. Act sets standards for the labelling of pesticides. A statement must indicate the minimum amount of each active ingredient, to be referred to by common name wherever possible. The net contents and physical form of the ingredients must be indicated on the container and directions for use must be adequate to preclude hazards from handling the exposure and to provide correct dosage. Cautions and restrictions on usage must be printed with directions for use. Advertising claims in Canada are required to conform to statements on the product label.

At the federal level, pesticides are designated by one of three marketing categories: "domestic", "commercial", and "restricted", according to the degree of hazard to which they will subject both humans and the environment. Presently, the dermal LD_{50} values[1] for products in each of the categories are as follows:

"restricted" : <100 mg/kg
"commercial" : 100 - 1,000 mg/kg
"domestic" : >1,000 mg/kg and oral LD_{50}>500 mg/kg.

The Environmental Contaminants Act (1976)

This Act empowers the federal Ministry of Environment to require from industry information on the nature, amount and environmental effects of substances deemed potentially harmful to health and the environment, and to control the manufacture, importation and use of these substances. The regulations and machinery for enforcement of this legislation are still in the process of being set up. A joint DOE-NHW Environmental Contaminants Committee is currently compiling a list of problem substances to be examined. Substances will be categorized according to degree of hazard, with corresponding restrictions applied to importation, manufacture and use. All substances imported in amounts greater than 500 kg per year will have to be registered. This

[1] For explanation of LD_{50} testing, see Section VI.

legislation is intended to fill in gaps in the present control of toxic chemicals rather than to supercede existing legislation. It may eventually affect the use of some pesticides containing toxic chemicals used for other purposes, for example, those containing heavy metals.

Evaluation and Registration Procedures

The federal Pest Control Products Act requires that all pest control products sold in Canada be registered by the Department of Agriculture. The information submitted by a chemical company in support of an application for product registration is evaluated by the Control Products Section of Agriculture Canada and Health Protection Branch of Health and Welfare Canada. Recently it has become customary for CWS to examine the ecological data. Other agencies of Environment Canada are sometimes consulted in assessment of the data. Health and Welfare and Agriculture Canada can request additional information from the company regarding its product; CWS and the Health Protection Branch submit their opinions regarding registration and permissible conditions under which the product may be used to the Control Products Section, where the final decision-making authority resides.

The information required in support of an application takes years to gather. It may vary from product to product, depending on the use for which the product is intended, method of application, expected distribution and other factors. In general, the following information is required:

Biochemical and Toxicological Information

A. Identification: common name; chemical name; structural formula; empirical formula; molecular weight.

B. Physical and Chemical Properties, of both the pure and technical material: physical state; colour; odour; melting point; boiling point;

density; viscosity; solubility; stability; corrosiveness; compatibility with other pesticides; degradation products.

C. Analytical Methodology: formulation analysis, methods suitable for the qualitative and quantitative determination of guaranteed amounts of parent compound in formulation; residue analysis, methods suitable for the qualitative and quantitative determination of residues and metabolites of the parent compound likely to be found on crops, in livestock, or in water and soil as a result of recommended use patterns.

D. Biochemical and Toxicological Properties

1. Plants: translocation; mode of toxic action; metabolism; degree of phytotoxicity.
2. Mammals: mode of toxicaction; metobolism; acute toxicity; subacute and chronic toxicity; neurotoxicity; reproduction studies; teratogenicity (production of abnormal offspring); mutagenicity (production of genetic changes); tumorigenicity (production of tumours); anitodotal studies; interaction; enzyme induction.
3. Birds: mode of toxic action; metabolism; toxicity - acute, subacute, other studies. Treat the above categories as outlined in the corresponding sections on mammals.
4. Cold-blooded Vertebrates: mode of toxic action; toxicity to fish; toxicity to reptiles; toxicity to amphibians.
5. Invertebrates: mode of toxic aciton; toxicity to insects; toxicity to molluscs; toxicity to annelids.

E. Ecological Aspects: effects on soil; effects on water; effects on air; residue studies on non-target organisms.

F. Use Pattern: (proposed) registered uses; (proposed) registered formulations; relationship to integrated control; pest resistance; host resistance.

G. Residues In Treated Crops and Animals: plant crops; animal products; fate of residues in storage and processing; Food and Agriculture Organization of the United Nations/World Health Organization, (FAO/WHO) acceptable daily intake; threshold limit value.

H. Disposal, Decontamination and Destruction: procedures and methods.[2]

The mammalian toxicological studies are conducted for the company by private laboratories. If no residues are detectable on treated crops, the Health Protection Branch requires only the following:

a) Acute oral toxicity studies on two species, one a non-rodent. Occasionally, acute oral toxicity studies on a metabolic product of the chemical may be required.

b) Subacute oral toxicity studies: The feeding of the compound to a minimum of two species (one non-rodent) for 90 days, using 3 - 5 dosage levels based on the previously determined lethal dosage (LD_{50}).

c) Acute and subacute skin and eye irritation studies (usually rabbit).

During the 90-day feeding studies, the animals are examined clinically for signs of toxicity; at the end of the 90-day period, they are autopsied and some organs examined histologically. One one-hundredth of the dosage level at which no effect was found is arbitrarily designated the permissible residue level for human ingestion. If food residues above this level are expected to occur, additional tests for carcinogenicity, teratogenicity, demyelination, effects on life-span, fertility, reproduction and postnatal survival and growth are required by Health and Welfare. These involve lifetime (two-year rodent) feeding and three-generation studies with one rodent and one non-rodent species.

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[2] Summarized from "Public Hearings into the Use of Pesticides and Herbicides in Alberta", Environment Conservation Authority, Information Bull. #3, 1974

Health and Welfare Canada are constantly seeking to update their technology for assessment of hazards to human health, although the funding for updating tests of mutagenicity has not been available to them.[3] This report would be negligent to avoid mention of the current expression of concern by geneticists in Canada and the U.S. regarding the possible hazard of some currently used pesticides, namely those which interact with cellular DNA. It has recently been shown that, in general, all chemicals having this capability are carcinogenic and mutagenic to a variety of organisms; often metabolism with the body bestows this capability on a substance.[4] The fundamental issues presently being raised regarding the safety of such chemicals are:

--the inability of the assays presently required by government for safety evaluation purposes to detect mutagenic or carcinogenic chemicals;

--the lack of knowledge of whether, when and how to extrapolate results from test species to man (due partly to a lack of information regarding comparative metabolism);

--the present lack of knowledge as to whether safe levels of exposure to mutagens and carcinogens exist (current findings point to the conclusion that they do not).

While it is outside the scope of this report to evaluate these issues, inasmuch as the possibility of pesticide use by the Division exists, a few examples of this concern are quoted below:

> Despite the extensive use of pesticides, our information on their mutagenicity is grossly inadequate. Several have been tested in various test systems, but we believe that none has had the kind of systematic testing that would be regarded as adequate. U.S. Department of Health, Education and Welfare, "Report the Secretary's Commission on Pesticides and Their Relationship to Environmental Health", 1969.

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[3] R. von Borstel, pers. comm.

[4] Hastings and von Borstel, Nature, in press.

It is now currently recognized that the current toxicological techniques are insensitive and relatively limited in their ability to detect carcinogens, individually and in various combinations or mixtures realistically reflecting low or ambient levels and patterns of environmental exposure. While this is largely due to the relatively small numbers of animals tested compared with the massive human populations at presumptive risk, this also reflects the simplistic nature of toxicological approaches, which are generally based on the testing of single chemical agents in isolation from the multitudes of other chemicals to which human populations are currently exposed. Dr. S. Epstein, 1974, Statement for testimony at cancellation hearings on Aldrin/Dieldrin, Environmental Protection Agency and environmental Defense Fund vs. Shell, March 1974 (reprinted in The Science of the Total Environment, 4 (1975) 1-52).

For our purpose at this public hearing I can only say that guidelines for making recommendations on the mutagenic hazards of a particular pesticide have not yet been established. We are presenting recommendations at this public hearing on four compounds used in Alberta: the two fungicides Captan and Folpet, the herbicide 2,4-D and the insecticide Dichlorvos. In each case more testing needs to be done, especially the carcinogenicity testing which is lacking for all the compounds. (Note: see Appendix A1 for these recommendations). Dr. R.C. von Borstel (Chairman, Genetics Department, University of Alberta, representing the Committee on Environmental Mutagenesis of the Genetics Society of Canada) "Proceedings of the Public Hearings into the Use of Pesticides and Herbicides in Alberta, October 1974-April, 1975", Vol. 5, Environmental Conservation Authority.

Appendix A lists some of the pesticides used in Alberta which are of concern to geneticists due to their probable mutagenicity.

Efficacy and Residue Testing

The field testing of new chemicals for crops and livestock is primarily done by CDA research farms in areas where the pesticide is expected to prove useful (with the exception of livestock pesticides). Allocation of compounds to various researchers for testing purposes is made at the annual meetings of the Western Committee on Crop Pests (WCCP), the Western Committee on Livestock Pests (WCLP), and the Canada Weed Committee.

The Canadian Forestry Service (Northern Forest Research Center) also does efficacy testing of candidate products designed to control pests of shade and shelterbelt trees. In 1975, field trials of 37 insecticides and 1 fungicide were conducted by this agency at 12 sites in Alberta.

In the field tests, the kinds of pests affected, the effect on crops or livestock, influence of environmental factors such as temperature on efficacy and crop residue levels and rate of disappearance of residues are measured as well as (in some cases) comparison of application techniques. These data enter into the final decision regarding the specific pests and crops or livestock for which the product will be registered.

Reregistration, Re-evaluation, Use Modification, Cancellation and Suspension

Registration of a compound is granted for only two years, after which time renewal of registration must be obtained. This fairly automatic process differs from that of re-evaluation, in which the data supporting the initial application for registration of a compound are reassessed and further data requested if necessary. This process has been applied to many of the older chemicals originally registered under less strict requirements. If upon re-evaluation, a potential hazard to human health or wildlife is perceived, "suspension" of further production and importation of the compound may be ordered, or "cancellation" of sales as well as production and importation. The latter has rarely been invoked, and the former is usually mitigated by placing the product "on notice", whereby a phasing-out of use in the indefinite future is signified but not effected until, or unless, an adequate substitute becomes available.

Notices of modification of registered uses are issued frequently by the Control Products Section as the result of further efficacy testing by research stations.

Committees Involved in Pesticide Policy-Making and Research

In addition to the WCCP and WCLP, a number of other federal committees have roles in pesticide research and policy-makings. The terms of reference and membership of these committees are presented in Appendix B.1.

The Federal Interdepartmental Committee on Pesticides (FICP) consists of representatives of all federal departments that are involved in the use of pesticides for various purposes. All proposed uses of pesticides by federal agencies are referred to the FICP for examination and approval. The FICP is not generally consulted by provincial governments for advice on pesticide use. If, however, a provincial agency feels that some pesticide is causing damage to the environment and that Agriculture Canada is not dealing effectively with the problem, FICP should be consulted through an appropriate member of the Committee (eg., Dr. Peakall). Whenever some members of the Committee are unable to come to agreement on an issue, those members involved in the debate are formed into a subcommittee to resolve the issue among themselves. The Committee's advice is communicated to the Minister of Agriculture and from him to the ministers of other departments concerned.

The Canadian Agricultural Services Co-ordinating Committee, members of which include the federal and provincial deputy ministers of agriculture and deans of the faculties of agriculture and veterinary medicine at Canadian universities, directs a number of "Canada Committees", which submit reports and recommendations for its consideration. These include, among others, the Canada Weed Committee, the Canada Committee on Grain Diseases and the Canada Committee on Pesticide Use in Agriculture (CCPUA). At the annual Western Forum meetings of the CCPUA, matters regarding pesticide registration, classification, testing and usage patterns are discussed among representatives of the western provincial departments of agriculture and university agriculturists, Environment Canada, Agriculture Canada and Health and Welfare Canada and pesticide manufacturing companies. There is a conspicuous lack of provincial environmental representatives at these meetings, with the exception of Alberta Environment.

A Federal-Provincial Task Force on Vertebrate Damage to Agriculture was established at the 39th Federal-Provincial Wildlife Conference in 1975. The purpose of the Task Force is to examine current data and research needs in the area of vertebrate predator control. Both wildlife and agricultural agencies are involved in this effort. Under the chairmanship of A. Keith, the Task Force includes federal and provincial agricultural and wildlife agencies.

LEGISLATION AND EVALUATION OF PESTICIDES IN ALBERTA

Legislation

The following provincial legislation has direct bearing on the use of pesticides in Alberta:

(1) Agricultural Chemicals Act (1969)
(2) Agricultural Pests Act (1974) - provides for the control of agricultural pests and nuisance animals.
(3) Alberta Pharmaceutical Association Act - regulates the sale of poisons, etc.
(4) Public Health Act - regulation of matters necessary for public health, etc.
(5) Livestock Diseases Act - regulates sale of livestock medicines, etc.
(6) Dairymen's Act - prohibits contamination of dairy products, etc.
(7) Municipal Government Act - permits by-laws for control of pests, etc.
(8) Environment Conservation Act - conservation of resources and pollution control, etc.
(9) Wildlife Act (1970) - provides for the protection of wildlife, etc.
(10) Clean Water Act - prohibits and regulates contamination of water, etc.
(11) Noxious Weeds Act - provides for control of weeds and use of herbicides, etc.

The Agricultural Pests Act

This Act plus 8 Regulations provide enabling legislation for the control of the more serious pests of crops and livestock. The Act provides two designations: "pests", which must be exterminated, and "nuisances", control of which is optional. Regulation 73/75 declared the provincial pests to be the Norway rat, bacterial ring rot (a disease of potatoes), the grasshopper and warble fly. In the nuisance category are the coyote, striped skunk and magpie.

This legislation, administered by the provincial Minister of Agriculture, places an obligation on all persons and municipalities to control pests, allows the Minister to supply poisons and pesticides, specifies how, where, when and which poisons may be used, and provides penalties for misuse. Authority is provided for appointment of officers, inspection of premises, taking of specimens, and the serving of notices directing the destruction, control or prevention of pests. Where required measures are not taken by landowners, any officer may secure appropriate material and take whatever action is necessary to destroy pests, with expenses incurred charged against the owner.

Regulations under the act are:

(71/75)	Devices for coyote control: Permits for using coyote control devices will be granted only upon assurance of training.
(72/75)	Magpie Control: Permit necessary
(73/75)	Pest and Nuisance: (described above)
(74/75)	Rat Control: Emphasizes proper use of rodenticides.
(75/75)	Bacterial Ringrot: Requires a permit for growing over one acre of potatoes.
(76/75)	Skunk Control: Strychnine is the only biocide approved for this purpose
(77/75)	Sodium Fluoroacetate for Coyote Control: Treated baits may not be placed within five miles of any city, town or village.
(78/75)	Warble Fly Control: Requires control of this pest by all livestockmen and municipal councils. Deals with imported cattle and market inspections.

The Agricultural Chemicals Act

The Agricultural Chemicals Act, passed by the 1969 Alberta Legislature, gives the Minister of the Environment the authority to issue licenses and permits for the sale and commercial application of pesticides and to prohibit the sale and use of pesticide-contaminated produce and water. All urban and rural municipalities are required to administer the Act and Regulations and to appoint sufficient inspectors to carry out the intent.

The Act imposes an obligation on all persons using pesticides to properly use, apply, transport, handle, store and dispose of them. Application of any pesticide on, in or within a horizontal distance of 30 meters from an open body of water without express permission from Alberta Environment is forbidden. (However, the term "open body of water" does not include lateral irrigation canals, lakes, ponds, reservoirs, or dug-outs totally on private land and having no movement of water from these lands).

The Agricultural Chemicals Act and Regulations allow the province to establish tighter restrictions on pesticide use within the province than those set by the federal Pest Control Products Act. Alberta Environment's proposed amendment to the A.C. Act and two regulations, described briefly below, will have this effect.

Pending provincial amendments to the A.C. Act and regulations

All federally registered pesticides will be placed in one of six schedules (presented in Appendix B):

Schedule A will contain five highly toxic chemicals that may be used only by licenced applicators with a permit from the Environment Department. Included in this category will be all compounds containing sodium flouroacetate, parathion, thallium, and TEPP (tetraethyl pyrophosphate).

Schedule B will contain about 14 chemicals which may be used only by licenced applicators, farmers and grain handlers, all of whom must obtain a specific use permit from the Department or their municipality. This category will include chemicals that present a fairly high environmental or occupational hazard, including strychnine $>2\%$, phostoxin, zinc phosphide $>5\%$, most fumigants and DDT.

Schedule C will contain approximately 60 chemicals of high occupational risk which will be available only to licenced applicators or farmers. No permit is required for these chemicals; however, the buyer must sign for the chemical, stating his intentions for use of the product.

Schedule D control products will also be available only to licenced aplicators or farmers. No permit or signature will be required. This category will include most of the herbicides and other control products that are considered fairly safe. These will be packaged in large containers and formulated in relatively high concentrations specifically for commercial use. Approximately 550 formulations will be involved.

Proof of licence will be required of an applicator for purchase of a pesticide and class of licence held by an applicator will determine which chemicals he may purchase.

Two domestic schedules, E and F will contain compounds available to the homeowner. These compounds will be formulated in low concentrations and available in one-season packages. Products in Schedule E can not safely be sold in food stores but will be available in hardware stores, seed houses, farm supply stores, garden supply shops, etc. This category would list approximately 1360 separate formulations, with LD_{50} values between 500 and 5,000 mg/kg and low inhalation risks. These compounds will be short-lived.

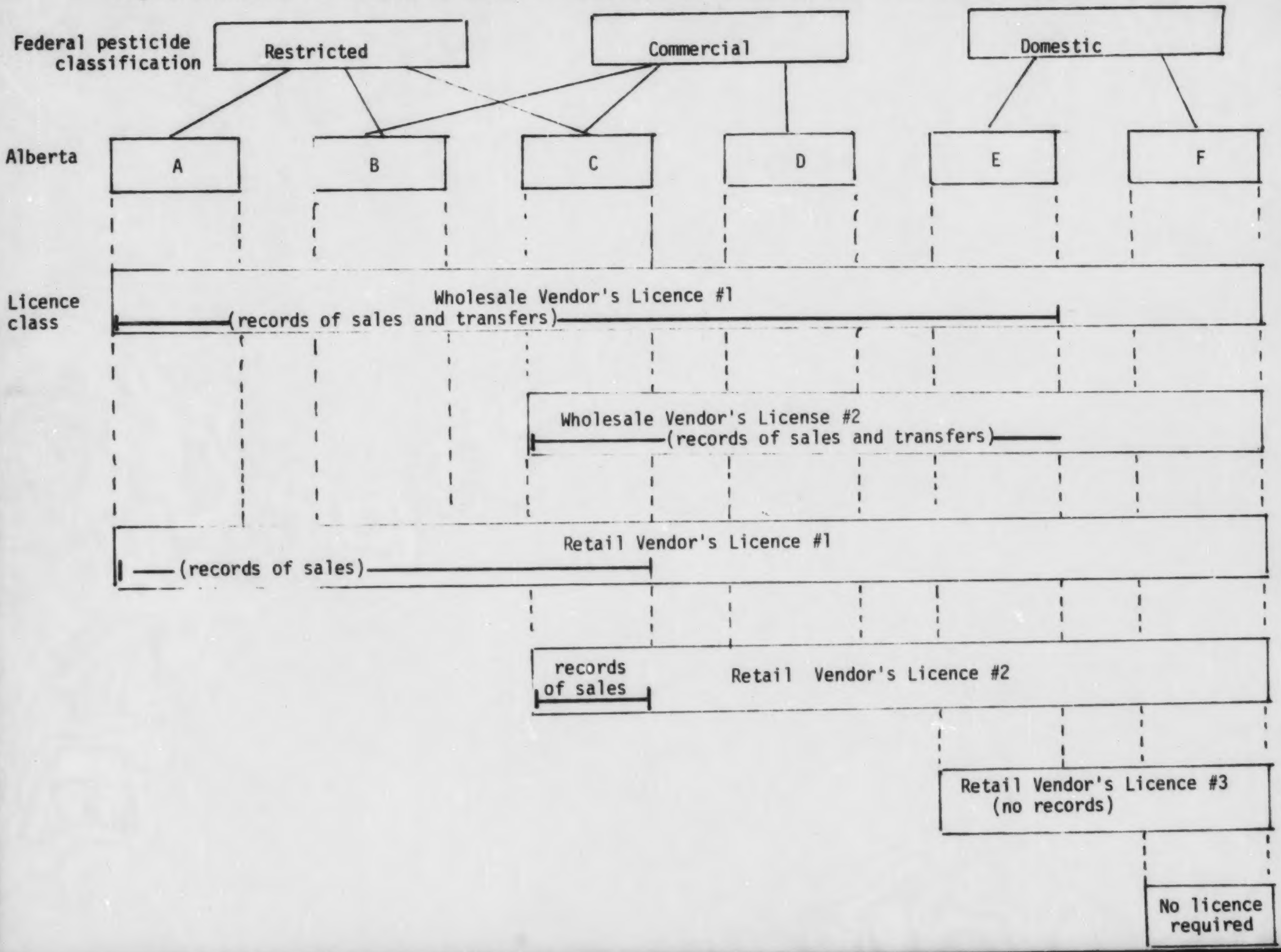
Schedule F will contain approximately 950 formulations that pose little risk to the user or the environment. These compounds can safely be sold through any type of outlet and will include many repellents.

In addition to the establishment of pesticide schedules, licence categories for pesticide vendors will be established (Figure 1):

The Class A Wholesale Vendor's Licence will allow the vendor to handle any class of pesticide. He will record sales and transfers of control products in Schedules A-E inclusive. A Class B Wholesale Vendor's Licence will allow the vendor to handle products in Schedules C-F and will require sales of Schedule C-E products to be recorded.

The Class A Retail Vendor's Licence will allow the vendor to handle pesticides on all Schedules, and will require sales in Schedules A, B and C to be recorded by the vendor. A Class B Retail Vendor's Licence will allow sales of

Figure 1. Alberta Vendor Licence and Record-keeping Requirements . (from Alberta Environment)


Federal pesticide classification
Restricted
Commercial
Domestic
Alberta
A
B
C
D
E
F
Licence class
Wholesale Vendor's Licence #1
(records of sales and transfers)
Wholesale Vendor's License #2
(records of sales and transfers)
Retail Vendor's Licence #1
(records of sales)
records of sales
Retail Vendor's Licence #2
Retail Vendor's Licence #3
(no records)
No licence required

compounds in Schedules C-F, while a Class C Retail Vendor's Licence will permit sales of compounds in Schedules E and F. Class C licences will not be required to record sales.

In addition, the proposed amendments stipulate that any pest control products applied to open bodies of water or used in forest management may only be applied by licenced applicators who have obtained a specific use permit from the Department.

The Wildlife Act

At present, the Wildlife Act deals with pesticides only to the extent of banning the use of poison for hunting purposes and allowing the use of biocides for management purposes. Consideration is presently being given to the addition of provisions for stop-orders and investigation of sources of toxic substances found to be harmful to wildlife in the province.

Municipal Legislation

Under the Provincial Municipal Government Act, a municipality may, in compliance with provincial legislation, pass a by-law for the control of pests and other nuisances, and may set the means and ways to achieve this objective. Most municipalities are now operating warble control areas under such by-laws. The County of Newell is establishing special requirements for control of bacterial ringrot of potatoes by municipal by-law. This Act has considerable potential use and allows for flexibility in the control of local or regional problems e.g. control of gophers, mosquitoes, diseases of special crops or ornamentals, etc. Provincial Acts and Regulations could be passed containing requirements for municipal by-law passage with regard to specific pest control problems thereby allowing for regional differences within the province.

Provincial Evaluation of Pesticides

The results of field tests in Western Canada are published annually by the Canada Weed Committee (Western Section), the WCCP and the WCLP. These are studied by the provincial Pest Control Advisory Committee (see below) with an eye to Alberta's particular needs. The Crop Protection and Pest Control Branch of Alberta Agriculture bases most of its recommendation on these. It also conducts some small-scale tests of its own and sponsors research, some of which involves pest control methods, via the Alberta Agriculture Research Trust Fund.

The Pesticide Chemicals Branch of Alberta Environment is represented at the meetings of research and policy-oriented pesticide committees on federal and provincial levels (see below). The Branch conducts some small-scale environmental studies on the effects of pesticides, and monitors many food items for pesticide residues. It keeps abreast of developments and restrictions in other provinces.

Provincial Committees Involved in Pesticide Policy-making and Research

The terms of reference and membership of the committees mentioned below are contained in Appendix C.

The Alberta Interdepartmental Committee on Pesticides is similar in structure to the FICP and has similar aims, one of which is to make recommendations regarding controls for regulation of pesticide use. The Fish and Wildlife Division is represented on this committee.

The Agricultural Chemicals Advisory committee, established to advise the Minister of Environment on matters relating to the Agricultural Chemicals Act, is also attended by a representative from the Department of Recreation, Parks and Wildlife.

The Alberta Blackfly Coordinating Committee, also attended by Fish and Wildlife, conducts research into the control of blackflies in the Athasbasca region and northern areas.

The Pest Control Advisory Committee, under the direction of the Alberta Agricultural Coordinating Committee (AACC), reviews pesticide research and advises Alberta Agriculture "on developments as they may affect department policies and farm practices". The Fish and Wildlife Division is represented. Also directed by the AACC, the Weed Advisory Committee recommends further research needs to the AACC and its federal counterpart.

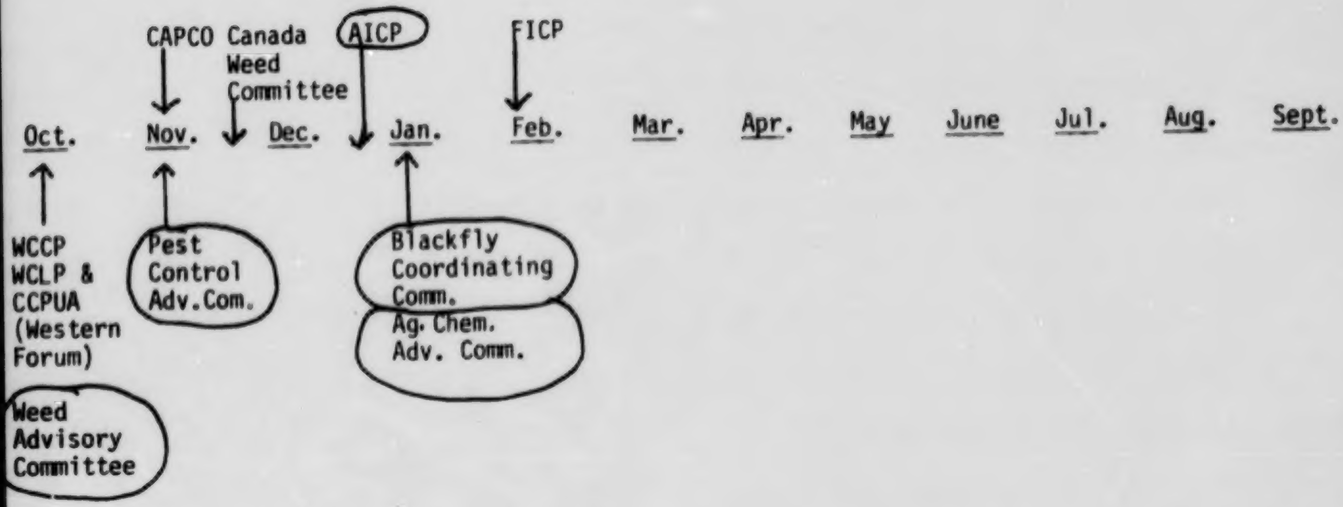
The Aquatic Plant Management Committee administrates aquatic and semi-aquatic weed control programs and advises on required research under the Ministers of Environment, Agriculture and Recreation, Parks, and Wildlife. The Fish and Wildlife Division is represented.

The Problem Wildlife Committee consists of members from the Fish and Wildlife Division and Alberta Agriculture. It reviews problems of vertebrate pest management and coordinates action between the two agencies.

An ad hoc interdepartmental committee under Alberta Environment, the Alberta Mosquito Control Committee consists of entomologists from Environment, the University of Alberta, and Agriculture. This committee publishes and updates the "Mosquito Control Guide" annually and its approval concerning the design of a mosquito control program is a prerequisite for financial assistance to municipalities for control programs. (In 1976, 30 municipalities received financial aid for this purpose from the Department of Environment). The Committee does in-house evaluating of mosquito control products and sponsors research in this field.

The sequence of the annual meetings of some of the above-described federal and provincial committee meetings in 1976 is shown below:

Figure 2. Annual Pesticide Committee Meetings, 1976.
(provincial committees are encircled)


CAPCO
Canada Weed Committee
AICP
FICP
Oct.
Nov.
Dec.
Jan.
Feb.
Mar.
Apr.
May
June
Jul.
Aug.
Sept.
WCCP WCLP & CCPUA (Western Forum)
Weed Advisory Committee
Pest Control Adv.Com.
Blackfly Coordinating Comm.
Ag. Chem. Adv. Comm.

PESTICIDE USE IN ALBERTA

As readily acknowledged by the Departments of Agriculture and Environment, the present sources of data for the amount and kinds of pesticides used in the province are inadequate. Chemical companies, distributors, and regional agricultural representatives presently provide the basis of estimated agricultural uses. Non-agricultural estimates are based on the required annual reports for licenced pesticide applicators and permits granted for application to open bodies of water by Alberta Environment. Major areas of inadequate data are: use by homeowners, municipalities, forestry, and power and pipeline companies. The proposed amendments to the Agricultural Chemicals Act described above will close the data gap by requiring records of sales by licenced vendors in Alberta. Agriculturalists plan to use the next census to obtain better data on quantities of pesticides applied by farmers.

Individual farmers and small businesses in the province can obtain a permit from Agriculture Canada to import a quantity of a pesticide for one year's worth of application to their premises. The product imported must be one which has been registered for use in Canada. Importation generally allows circumvention of the Canadian mark-up and also provides a means of obtaining chemicals which may be in short supply in Canada. The amount of agricultural pesticides imported into Alberta by this method in 1976 is estimated at 165,000 lbs. Unregistered pesticides and unregistered formulations of registered pesticides gain entry in this way, since customs can only spot-check and is not always checking permits for agricultural chemicals, which are not subject to any excise tax.

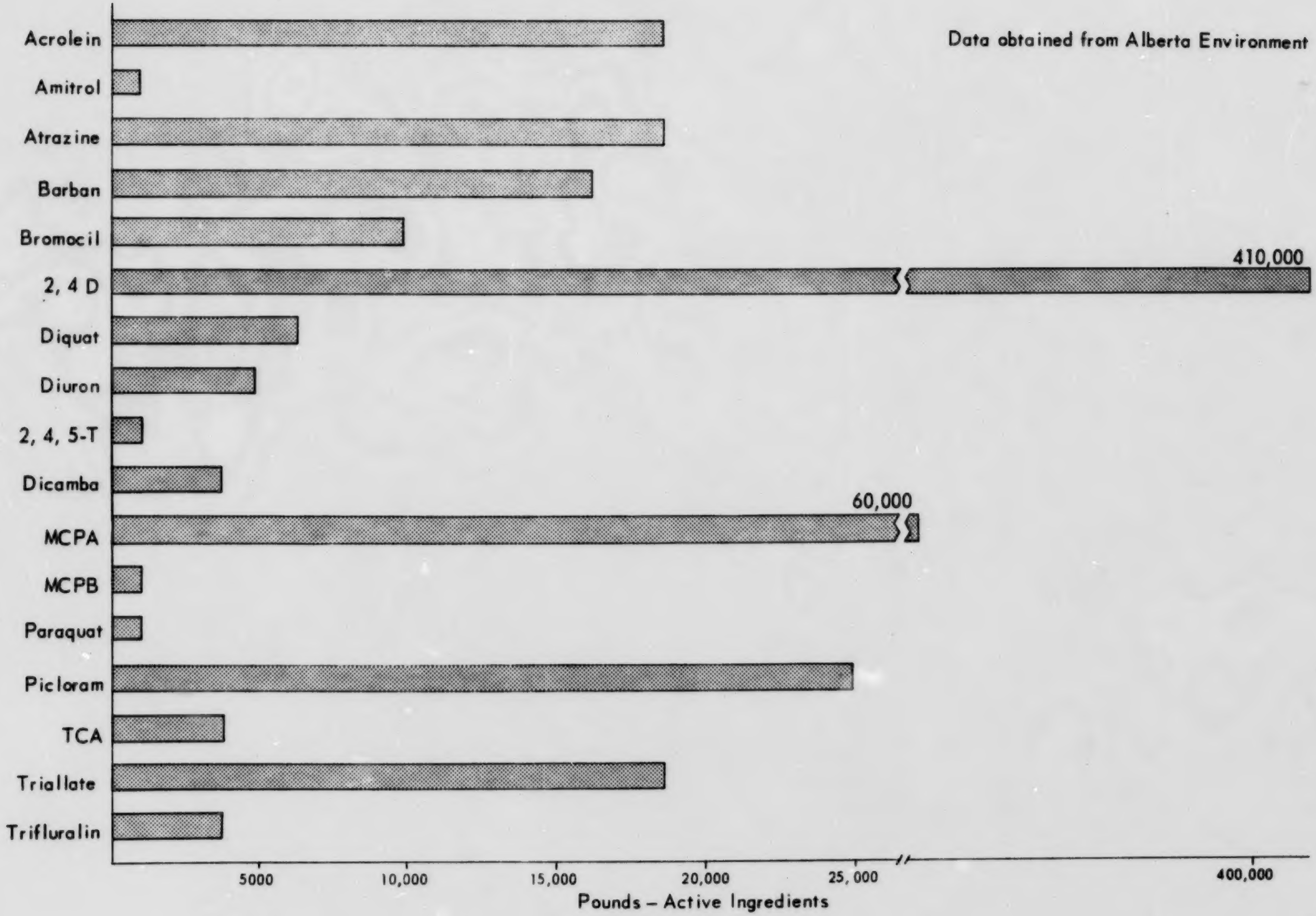
Herbicides[1]

Figure 3 shows the amount of herbicides applied by licenced pesticide applicators in Alberta during 1975, as calculated from their annual statements required for licence renewal by Alberta Environment.

Agriculture

The phenoxy herbicides 2,4-D and MCPA are without a doubt the most extensively used herbicides in the province, with approximately 3.8 million acres (1.6 million lbs.) treated with 2,4-D and 2.4 million acres (1.1 million lbs.) treated with MCPA during 1975. These herbicides are used against broadleafed weeds in cereal crops. The salt and amine formulations of these chemicals, being less volatile than the esters and hence giving less problems with drift, are gaining in popularity among farmers, although the ester formulation of 2,4-D is still used in greater quantity than the amine. In 1975 approximately 32,000 lbs. of another phenoxy herbicide, dalapon, were sprayed in Alberta to kill grass or green foxtail in flax, rapeseed and sugarbeet crops. Irrigation ditches were also treated with dalapon for weed control in the Lethbridge Northern Irrigation District.

[1] These data were obtained from two sources: 1) Manitoba Dept. of Agriculture, "Herbicides Used Agriculturally in Western Canada for Weed Control", 2) Alta. Env. 1976, "Total Pesticides Applied by Classes of Pesticide Applicators in Alberta in 1975 by Class."



Data obtained from Alberta Environment

Figure 3 Application of Herbicides in Alberta by Licensed Applicators in 1975.

For control of wild oats, 3.4 million acres were treated with one of several chemicals in 1975: diallate (Avadex), triallate (Avadex BW), barban (Carbyne), trifluralin (Treflan), benzoprop (Endaven), asulam (Asulox) and difenzoquat (Avenge). Two broad-spectrum herbicides are sometimes used in cereal crops in the province: bromoxynil mixed with MCPA (Buctril M, Brominal M) and dicamba (Banvel), the former used particularly against 2,4-D and MCPA-resistant broadleafed weeds. In 1975, 346,000 lbs. of TCA (trichloroacetic acid) were used to control green foxtail in cereal, rape, flax and sugar beets. Other herbicides that receive relatively low volumes of use in the province include: dichlorprop, benazolin, diuron, nitrofen and aminotriazole (Amitrole).

Aquatic

A number of aquatic algicides and herbicides are recommended by the Aquatic Plant Management Committee for use in Alberta. Acrolein is used in irrigation canals in southern Alberta for control of submergent and floating plants; approximately 18,000 lbs. of this chemical were applied by licensed applicators in 1975. Diquat and paraquat are used in farm ponds, dugouts and ditches as well as in the current weed control program in Lake Wabamun. Other chemicals recommended by the Committee for submergent and emergent aquatic plants include: aminotriazole (Amitrole), chlorfenac (Fenac), endothal, dalapon, 2,4-D and 2,4,5-TP (Silvex). Copper sulfate and copper triethanolamine are recommended for algal control.

"Brush control"

In addition to the extensive use of the phenoxy herbicides on crops, 2,4-D is also used, often in combination with 2,4,5-T, for weed and brush control along roadsides, railways and power transmission and pipeline right-of-ways. A mixture of 2,4-D and picloram (Tordon 101) is often used for highway "brush" control, and 2,4,5-T and picloram (Tordon 155) for right-of-ways. In 1975, 26,4000 lbs. of picloram and 1,789 lbs. of 2,4,5-T were applied by licensed applicators in the province. Picloram is effective against most non-grass species, while 2,4-D kills broad-leaved herbs, willow, snowberry, silverberry, poplar and other shrub species with the exception of rose and raspberry species, which are killed by 2,4,5-T. Bromacil, essentially a soil-sterilant (as is picloram), has been used by the CNR in Alberta. Another soil-sterilant, tebuthiuron, is used around industrial sites (200 lbs. a.i.[2] were applied by licensed applicators in 1975 according to their annual reports).

Grazing Reserves

The Grazing Branch (Lands Division) sprayed 2,4-D with 2,4,5-T on approximately 9,500 acres of grazing reserve in western Alberta in 1976 for the maintenance of grassland on previously cleared land. This spraying regime has been conducted for the past 6-8 years, although this is the first year in which 2,4,5-T has been used on all the land sprayed. Currently the Branch is experimenting with the use of 2,4-D with picloram on an 80-acre plot for maintenance of grass. It is also conducting trials on a 400-acre area with 2,4-D and 2,4,5-T for chemical clearing of mature and young aspen.

Forestry

The Alberta Forest Service does not use herbicides in general practice. However, for the past several years the Service has been experimenting on a small scale with chemical clearing of sites to be reseeded. These trials have involved the aerial application of Tordon 101, 2,4-D and 2,4,5-T mixtures and several unregistered chemicals in an attempt to rid the sites of alder and willow and at the same time suppress future suckering, thereby discouraging the hare population on sites to be seeded.

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[2] a.i. = active ingredient

Fish and Wildlife Division

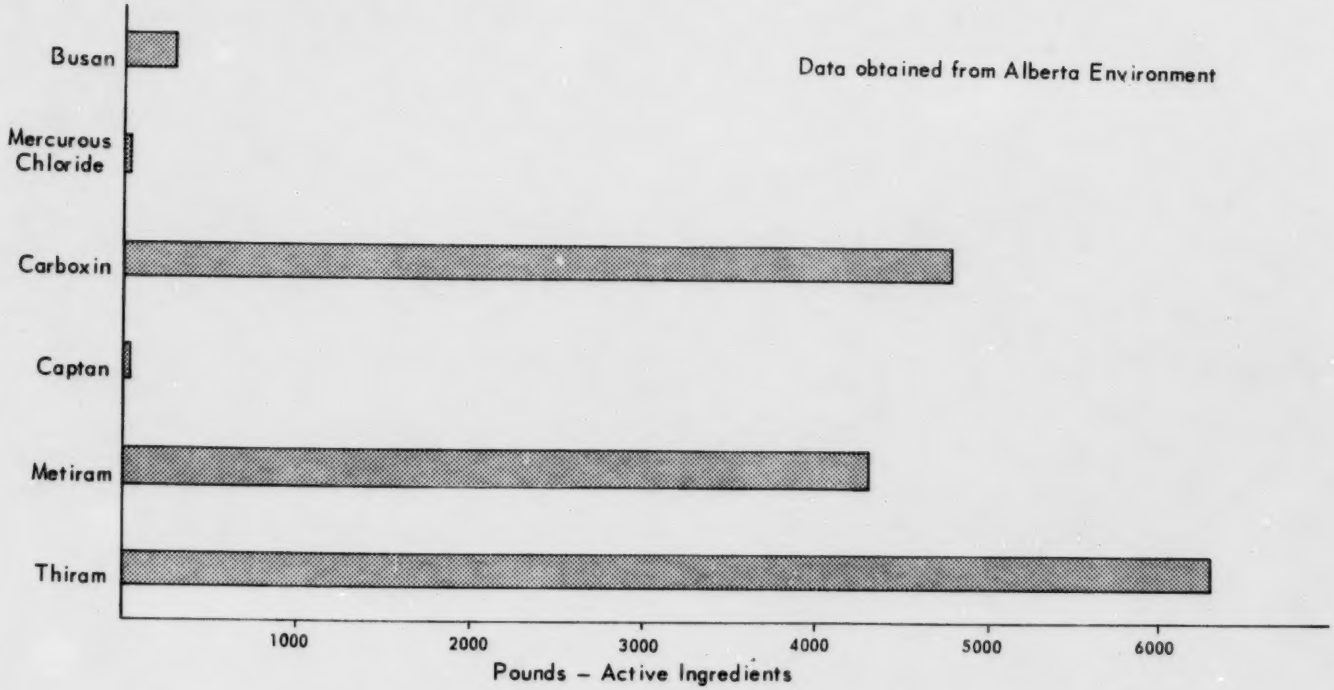
Several herbicides are being used experimentally in habitat development programs. Trifluralin is being used for suppression of annual weeds on newly planted shelterbelts, and linuron for weed control in established shelterbelts. For stabilization of grassy habitat on islands in Chip Lake for nesting Canada geese and ducks, a combination of burning and application of 2,4,5-T is being used to stop grass encroachment of trees for preservation of deer and upland bird habitat.

Fungicides

Figure 4 shows the amount of fungicides applied by licensed applicators in the province in 1975 (according to their own statements).

Agriculture

Fungicides are used in Alberta primarily for control of covered and loose smut in oats and barley, bunt and loose smut on wheat, seed rot and seedling blight. Metiram (Polyram), maneb, busan, mancozeb and a carboxin-thiram mixture (Vitaflow) are recommended by Alberta Agriculture as seed treatments for these diseases. Cereal seeds are treated with fungicide-insecticide mixtures containing lindane and either captan, thiram, maneb, carboxin, busan or metiram. After the withdrawal of the mercurial fungicides in 1970, and the subsequent ban on their importation and manufacture in Canada, the percentage of treated seed used in the province dropped greatly. It is estimated that presently about 35% of all seed sold in the province is treated with fungicide or fungicide-insecticide mixtures.



Data obtained from Alberta Environment

Figure 4 Application of Fungicides in Alberta by Licensed Applicators in 1975.

In southern Alberta, potato seed pieces are treated for fungal infections with benomyl, thiram, captan, maneb, metiram, or thiophonatemethyl. For early and late blight, potato plants are sprayed with captafol, chlorothanlonil, maneb or mancozeb.

Non-agricultural

Wood preservatives are usually fungicides. The most commonly in use are pentachlorophenol and creosote, the former now used in paper pulp manufacture in place of mercurials.

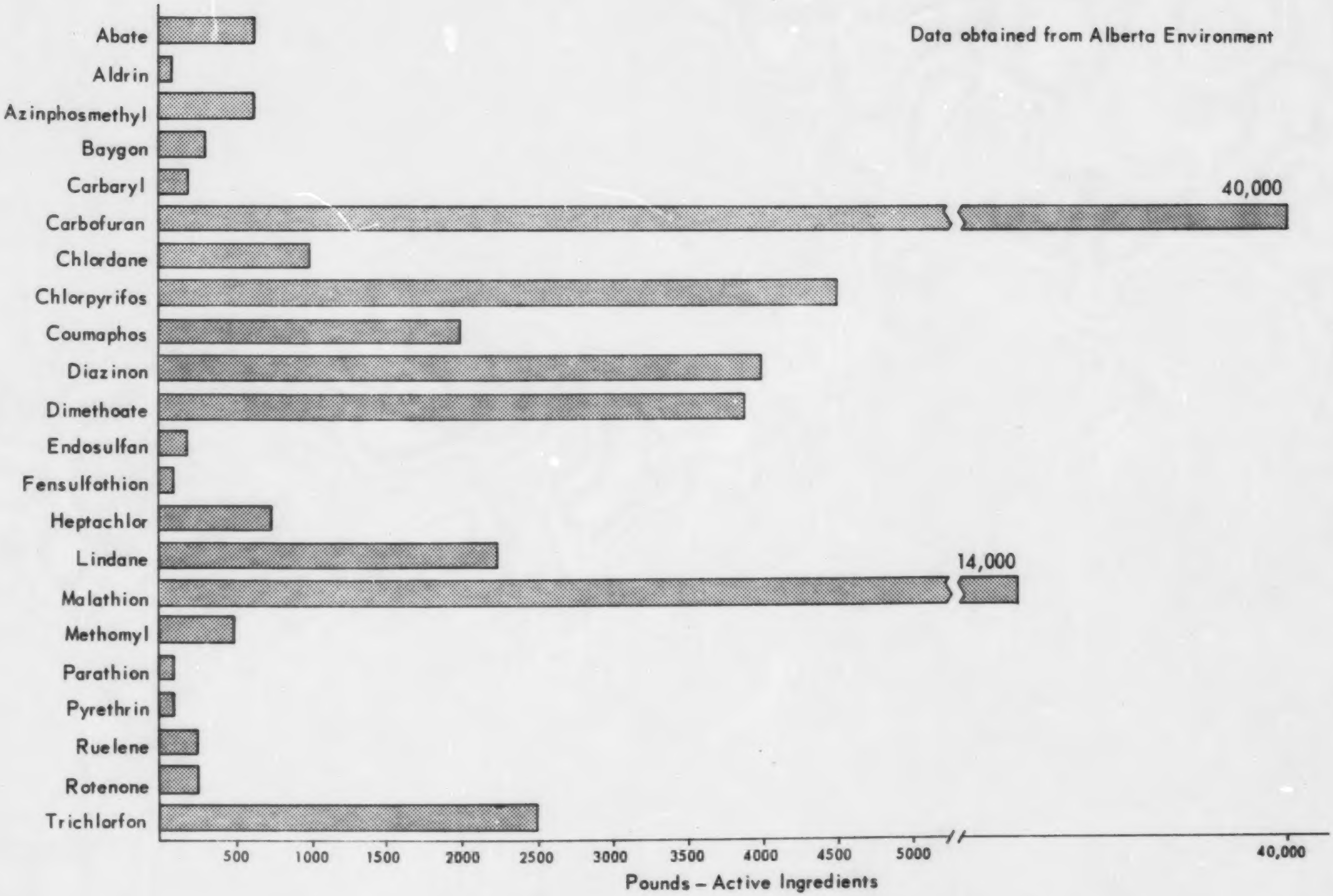
Golf courses and home lawns use benomyl, chloroneb, or quintozene for control of snow molds. Mercurous chloride (Calomel) is also used as turf fungicide in the province. Copper sulfate is available for domestic use against mildews and tomato blight.

Insecticides

Figure 5 shows the amount of insecticides applied by licensed applicators in the province in 1975.

Agriculture

The employment of insecticides for agricultural use varies from year to year. In 1973, for example, the most extensively used insecticide in the province was methomyl (Lannate) due to the bertha armyworm infestation, whereas in 1976, its use was far outweighed by dimethoate and carbofuran (Furadan) for grasshopper control. Approximately 100,000 acres were sprayed for grasshopper in 1976. Carbofuran was also used against the red turnip beetle in rapeseed. Lannate is used against the alfalfa looper, a serious pest in rape. Azinphos-methyl is used for several kinds of beetles in the province. Chlorpyrifos (Lorsban) was applied for cutworm and alfalfa looper (approximately 4,600 lbs. applied commercially in 1975).



Data obtained from Alberta Environment

Figure 5 Application of Insecticides in Alberta by Licensed Applicators in 1975.

Local legislation in 95% of the province makes control of warble flies in cattle compulsory. The organophosphates coumaphos, crofumate (Ruelene) and trichlorfon are used systemically for the grub stage (approximately 2,000 lbs. of coumaphos were applied by commercial applicators in 1975) and rotenone for the stage at which contact insecticides are effective.

The Alberta Blackfly Control Program, under the direction of the inter-departmental Alberta Blackfly Coordinating Committee, has for the past three years attempted to reduce harrassment of livestock by blackflies in the region north of Athabasca by release of methoxychlor into the Athabasca River. A 7½ - 14 minute pulse of 0.3 ppm. methoxychlor is introduced once each spring at 2 sites, one immediately downstream of the town of Athabasca and the other 100 miles downstream of the first. Environmental parameters are being monitored by Freshwater Institute, CDA (Lethbridge) and Alberta Environment (See Sect.V).

Forestry

No severe outbreaks requiring control have occurred in Alberta forests in recent years; however, signs of past heavy outbreak of the indigenious spruce budworm population exist and should such an outbreak occur again, insecticides would probably be employed.

Parks

The National Parks in general discourage the use of pesticides. Some fogging of adult mosquitoes in campgrounds is still done occasionally but is reduced from past amounts and is thought to be ineffective.[3] (Elk Island National Park, on the other hand, presently does no mosquito control but is considering fogging operations in the future). Infestations which have occurred in recent years, such as spruce budworm in Wood Buffalo Park, and spruce bark beetle in Waterton National Park, have not been treated with insecticide.

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[3] G. Rogers, pers. comm.

The provincial parks policy in Alberta with regard to pesticide use is also in general to let nature take its course. No spraying, larviciding or fogging of mosquitoes or blackflies is done, and the only insecticide employed is malathion for control of certain insects on ornamental trees. Where lawns exist, dandelions and thistles are eliminated with 2,4-D. The broad spectrum herbicide paraquat (Gramaxone) is sometimes used around trees. Weeds felt to be detrimental to nearby farms are controlled by the Department of Agriculture.[4]

Municipalities

Many municipalities in the province carry out activities aimed at mosquitoes. Two methods are employed: the spraying of larvicides and the fogging of adult mosquitoes. For the former, temephos (Abate) and chlorpyrifos (Dursban) are often employed; for the latter, malathion, fenthion (Baytex) and propoxur (Baygon) are used. The former method necessitates information as to proper timing and location of treatment, which the latter, a highly contested practise, does not. These operations do not require permission of Alberta Environment unless open bodies of water are sprayed. Where a municipality requests assistance from the province in conducting a mosquito control program, its program must meet the approval of the Alberta Mosquito Control Committee.

Domestic

Malathion, carbaryl (Sevin) and dimethoate are the most commonly recommended (and hence probably most commonly used, although no data are available) for urban tree insect pests (aphid, spruce sawfly, pear slug, etc.) Diazinon (for aphids), pyrethrin and rotenone are also recommended by the Northern Forest Research Center for certain insects. Chlordane is sold for household use against ants and cockroaches.

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[4] R. Mangot, pers. comm.

Other

Sites of industrial activities in the province are often sprayed for insects. Such spraying operations do not require permission from Alberta Environment (unless open bodies of water are involved).

Fumigants, heavy poisonous gases which penetrate the material to which they are applied, are used as insecticides in granaries, food warehouses, greenshouses and buildings and include chloropicrin, carbon disuphide, ethylene dibromide, methyl bromide, phosphine, malathion, lindane and others.

Vertebrate Biocides and Repellants

Vertebrate Biocide Legislation

As of a 1975 Order in Council regulating the 1974 Agricultural Pests Act, the only vertebrate species in Alberta officially designated a "pest" is the Norway rat. By definition of "pest" under the Act, the killing of this animal by property owners is compulsory. Three vertebrates species are official "nuisances" (allowed but not required to be eliminated by property owners) under the Act: the magpie, striped skunk and coyote.

Vertebrate Biocide Administration

The Crop Protection and Pest Control Branch of Alberta Agriculture administers pest control programs in agricultural areas, develops methods of pest control, makes pest control products available and distributes educational material on pest control. The Fish and Wildlife Division handles pest control in forested and green zones and in the border areas between agricultural and these zones. Formation of the Problem Wildlife Committee in 1973 has led to a cooperative approach to the use of pest control methods between the two agencies.

Pesticides and Repellants Used and/or Recommended

1. Rodents and Other Small Mammals

A recent publication by Alberta Agriculture recommends the following anit-coagulant compounds for control of mice: warfarin, pindone (Pivol, Pivalin), fumarin (Ratafin), diphacinone (Ramik) and norbromide (Raticate). Registration of the last of these products has since been discontinued at the federal level. Strychnine-treated mouse seed is also mentioned as being available. Judging from the numerous mouse seed-caused incidents of strychnine poisoning in Alberta in 1975,[5] the latter method of mouse control must be relatively popular.

Under an active Norway rat extermination program in the province, 70 tons of arsenic powder were distributed between Medicine Hat and Provost in 1952-53. Use of this chemical was discontinued soon thereafter. The program now uses warfarin primarily: a yearly average of 2,000 quarts of soluble warfarin and ten tons of rolled oat bait containing warfarin is supplied free of charge to property owners. The effectiveness of the more recent anti-coagulants such as those recommended for mice is also being studied by Alberta Agriculture, in the event that rat resistance to warfarin develops in the province as it has in other places.

Diphacinone is used in the extermination of bats. Although Alberta bat populations are known to contain rabies, no extermination program exists aside from an effort to exterminate those colonies thought to pose a risk to humans.

An Agriculture Canada publication distributed recently by Alberta Agriculture advocates the use of phostoxin (aluminum phosphide) for groundhogs (*Marmota monax*) in cases where spring plowing or shooting is not feasible. Phostoxin, which emits a colorless, odorless gas, can be purchased only by licensed applicators according to federal restriction; upon passage of the amendment to the Agricultural Chemicals Act, a municipal permit will be required for its purchase. The publication also recommends use of sulfur dioxide fumigating devices.

Alberta Agriculture is conducting research on the control of Richardson's ground squirrel populations by anti-fertility agents. In 1975, the use of 2% liquid strychnine mixed with grain and 0.2% gophacide (an organophosphate) were recommended as the only practical methods for large-scale control of ground squirrels; however, gophacide has been withdrawn from use and all strychnine except mouse seed is now on the federal Restricted list, requiring the signature of a licensed applicator of bona fide farmer. The anti-coagulants available for rodent control may prove to be effective for control of ground squirrel and other rodents as well.[6] Fumigation by experienced operators using calcium cyanide, carbon bisulphide and methyl bromide is also recommended for the Richardson's ground squirrel. These methods and the use of 8% strychnine grain baits (colored green so as not to attract the attention of birds) have recently been recommended for the Columbian ground squirrel.

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[5] See Section VI.

The gopher burrow-building machine combined with the use of either 8% strychnine bait or 0.2% gophacide has in recent years been recommended for use against the pocket gopher (Thomomys talpoides).

Thiram is available as a repellant for protecting trees from the snowshoe hare.

2. Skunks

Although skunks are a provincial "nuisance" rather than "pest", the program to exterminate skunks along the Alberta/Saskatchewan border, begun in 1971 under the Central Rabies Control Commission, is still ongoing. This effort, carried out in conjunction with the rat control program along the same border, employs strychnine sulfate pellets containing 0.5 grains of poison and a skunk attractant.

3. Wolves and Coyotes

The Problem Wildlife Committee endorses the policy of selective elimination of those individual coyotes and wolves which are responsible for attacks on livestock. For this purpose, trapping or poisoning at the location of known kills is permitted. Compound 1080 (sodium fluoroacetate) is no longer used by the Fish and Wildlife Division for this (or any) purpose. It must be requested by a municipality or local government and set out by pest control officers. Only two municipalities, Cardston and Pincher Creek, requested this compound in 1976. Baited sodium cyanide spring-loaded injection "guns" and strychnine cubes are the usual means of poisoning coyotes and wolves. A Form B certificate of training must be obtained from a pest control officer for use of the sodium cyanide gun. Table 1 shows the amount of use of these poisons over the last 15 years.

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[6] J. Gurba, pers. comm.

4. Birds

Circular traps are now advocated by Alberta Agriculture for control of magpies harrassing livestock. Strychnine baits placed on poles in the winter are also allowed.

In southern Alberta, blackbird blocks feeding on corn may now be deterred by the placement of Avitrol (4-aminopyridine)-treated cracked corn in fields. Birds eating this bait give distress signals and become ill or die; the flock, alarmed, flies away and apparently does not return. However, the efficacy of this treatment in low-density flocks is low.

5. Fish

Rotenone is presently used by Fish and Wildlife personnel for elimination of non-sport fish in lakes to be restocked with sport species (for example Carson Lake). It is not presently registered for use as a piscicide, although a request for a change in registration to allow for this is under review. Antimycin, which was registered as a piscicide, has been withdrawn from the market. Toxaphene is no longer used by the Division.

The policy of the Division in regard to biociding of fish is to undertake this practice only in areas of high fishing demand where predator or competitor

Table 1. TOXICANTS DISTRIBUTED FOR PREDATOR CONTROL BY ALBERTA AGRICULTURE, 1951-1975

(Source: Alberta Agriculture Annual Reports, 1951-75)

Year	Number of			
	Cyanide Cartridges	Strychnine Cubes	1080 Baits	No. of Municipalities Using 1080
1951	11,510	--------	50	2 (experimental)
1952	12,460	--------	157	13
1953	46,030	116,000	174	13
1954	20,110	192,000	381	19
1955	10,990	195,500	387	30
1956	5,000	124,000	753	39
1957	4,140	76,000	778	47
1958	1,230	58,500	749	50
1959	820	66,000	632	55
1960	1,170	59,000	529	54
1961	1,120	39,000	605	53
1962	1,780	53,000	573	59
1963	1,300	50,800	368	47
1964	1,130	38,800	448	52
1965	700	36,650	402	47
1966	570	28,550	242	28
1967	840	33,500	256	40
1968	735	34,000	247	38
1969	542	15,000	108	14
1970	1040	21,500	114	14
1971	1165	17,820	103	14
1972	3517	39,414	90	11
1973	3150	30,690	72	8
1974	1841	22,450	27	3
1975	1529	21,700	25	3

non-sport species have taken over. Biociding will not be used a) where unusual or rare natural species occur, b) in flowing water where downstream control cannot be effected, and c) in cases where an objection has been registered. A permit is required from Alberta Environment for this use. Currently a change in the federal Fisheries Act is being considered to allow for this practice.

THE MONITORING SCENE

Fate of Pesticides in the Environment

It is estimated that during the period of herbicide spraying, a total of one million pounds or more of the phenoxy herbicides enter the atmosphere over the prairie provinces.[1] In a 100-day study in Pullman, Washington during the main period of herbicide spraying, from one to four 2,4-D esters were present in the air over the city during 50 of the days.[2]

In a 1973 study at Regina, Indian Head and Swift Current, Saskatchewan, butyl esters of 2,4-D (but not the iso-octyl or amine salt forms) were detected in the air at concentrations up to 6.75 micrograms per cubic meter.[3]

Pesticide losses to the atmosphere of up to 50% commonly occur due to volatilization between the time the spray leaves the nozzle and the time it reaches the soil.[4] In a study in which soil samples were taken immediately after application of conventional spray formulations, 16% of the dimethoate applied and 18% of the disulfoton were not recovered;[5] while in another study involving aerial spraying, 65% of the diazinon and 55% of the aldrin were lost due to volatilization.[6] Many chemicals are more volatile than aldrin. Chemical structure is of course the primary factor in volatility; in general, esters are more volatile than acids, which are more volatile than salts.[7] The amounts of chemicals lost in the above studies, in accordance with the laws governing volatility, were found to be temperature-dependent.

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[1] J. Patterson, pers. comm.
[2] Wheatley, in Edwards, 1973.
[3] Canada Weed Comm., 1973, p. 430.
[4] Wheatley, in Edwards, 1973.
[5] Ibid.
[6] Ibid.
[7] Friesen, H., 1970.

Particulate drift has received more attention than volatility as a factor in the non-recoverability of pesticides. Dust and fogging methods are the worst villains in this respect and are being phased out for most purposes. Granular formulations are gaining in popularity, and various chemical agents designed to reduce drift by particulating, emulsifying, or thickening are commonly added to pesticide formulations for aerial spraying, for example, bentonite clay with chlorpyrifos (Dursban) and temephos (Abate) and diesel oil with 2,4-D. Sprays applied by helicopter and fixed wing aircraft are subject to complex air currents (the helicopter rotor action, once thought to be advantageous in creating downward air currents, does not in fact have this effect except at very low speeds[8]). Wind speed and air currents are critical in influencing the amount of drift that occurs. Type of nozzle also affects drift.

Additional quantities of pesticide enter the atmosphere from the surfaces on which the pesticide has landed. This continual release to the atmosphere may seem negligible on a local scale, but over a large area and period of time contributes significantly to the total atmospheric load. Re-entry from surfaces may take place in the form of vapor, liquid droplets, or solid particles. From the soil surface, volatilization is governed by the amount of moisture and organic matter in the soil as well as by the pesticide properties.[9] Wind-eroded soil and weathered surfaces to which pesticides are adsorbed can be transported to high altitudes and redeposited as rain or sediment. It has been shown that atrazine and 2,4-D esters adsorbed onto soil particles were precipitated out three weeks after their application at a distance of over one mile from the site of application.[10]

[8] McEwen et al., 1971

[9] Friesen, 1970.

[10] Wheatley, in Edwards, 1973.

With the detection of pesticides from West Africa over Barbados, it was first recognized that redistribution of pesticides can be global.[11] The less stable pesticides, on entering the atmosphere, probably undergo rapid photo-alteration and/or other reactions to a variety of as yet unidentified compounds, while the more stable pesticides may persist relatively unchanged, eventually precipitating or settling out.

Of the portion of pesticide that reaches soil and plant surfaces, the eventual fate may be microbial, chemical or photolytic degradation, uptake and metabolic degradation by plants, leaching through the soil (sometimes accompanied by lateral movement in the soil, as in the case of lindane), or surface run-off onto adjacent land, wetlands, or watercourses.

Pesticides entering streams and rivers are gradually taken up by the mud and organic matter in the stream bed. In aquatic environments in cold climates, microbial degradation of pesticides can be very slow. The process is chiefly anaerobic, as opposed to aerobic microbial breakdown in soil, and the pathways involved and extent of breakdown are not known.[12]

Leaching of most pesticides does not occur below a few centimeters in the soil and does not constitute a pollution problem for groundwater. However, fenac and 2,3,6-TBA have been found in significant quantities at 4-5 foot depths. Picloram may also leach to these levels.[13]

Problems in Monitoring

Apart from the problem of knowing which breakdown products of pesticides to look for in various environments and animal tissues, a few additional problems should be mentioned.

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[11] *Ibid.*
[12] Friesen, 1970.
[13] *Ibid.*

Photoalteration of Pesticides

Any residue monitoring problem is magnified by the inability of monitoring systems to detect pesticide residues which have been altered upon exposure to light. According to a meeting of pesticide chemists in 1973, the magnitude of these chemical alterations cannot even be estimated yet.[14] Photoalteration can occur in pesticides which have entered the atmosphere and also on organic pesticide films which form on water, soil and plant surfaces.

Impurities in the Formulated Products

New detection devices have revealed relatively large amounts of nitrosamines, which are potent carcinogens, in several pesticides tested in the U.S. in 1976.[15] The pesticides and amounts of nitrosamines found were: trifluralin (Elanco)-154-ppm; 2,3,6-TBA (trichlorobenzoic acid, marketed as Trysben by duPont - 187-195 ppm, and as Benzac by Amchem - 640 ppm); and several weed-killers sold to householders. The number of other pesticides examined for nitrosamines is not known. According to Plant Products Division, Ottawa, this contaminant results from the addition of sodium nitrate, an anti-corrosion agent, to those pesticides which are to be stored in metal containers.

Interactions in the Environment

It is now believed that nitrosamines can form when certain pesticides are plowed into the soil along with nitrogen-containing fertilizer.[16] Atrazine is one herbicide for which this is suspected. While this is more of a concern for human health authorities than for ecologists, it illustrates the need to ascertain the fate(s) of a chemical in the environment before its effects can be adequately assessed.

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[14] Anon., 1973.
[15] Washington Post, Sept. 3, 1976.
[16] Ibid.

Monitoring Programs in Alberta

Is the current application of pesticides, with the associated processes of re-distribution, resulting in ecologically hazardous levels in the streams, wetlands, aquatic life, birds and terrestrial flora and fauna of the province? With a few exceptions, this question cannot be answered, as few monitoring programs exist in the province today.

Water quality. The provincial environment department is unable to conduct a regular water monitoring program for pesticides because of a shortage of staff, in spite of the fact that the Pollution Control Laboratory in Edmonton is equipped to analyze a wide variety of pesticides. Water sampling is done on a need-to-know basis when contamination due to pesticide application is suspected. Under the National Water Quality Monitoring Program, Inland Waters examines some of the major rivers in the province for the presence of certain pesticides; the emphasis, previously on the organochlorines, has shifted in recent years to the phenoxy herbicides, BHC's and cyclodienes. However, sampling is done only four times per year, at nine stations which are located on large water courses not selected for proximity to sprayed areas. A special program in 1974 sampled streams and an irrigation canal before and after nearby farmland had been sprayed with dimethoate and carbofuran. Since no residues were found, further studies of this type are not planned for Alberta by Inland Waters.

Atmosphere. There is no provincial monitoring of pesticides in the atmosphere.

Fish. There are no pesticide monitoring programs for fish, with the exception of the monitoring of organochlorine content in commercial fisheries in Alberta by the Fisheries and Marine Service and analysis of lake trout in Cold and Primrose lakes by Fish and Wildlife. Otherwise, the Division takes samples for residue analysis only in instances of reported fish kills.

Monitoring of fish in the Athabasca River has been conducted as part of the experimental blackfly control program (see below).

This lack of monitoring is particularly conspicuous in light of the fact that fish are often the most sensitive of all organisms to pesticide (and other foreign chemical) levels in water, with LC_{50}'s (median lethal concentrations) often several orders of magnitude smaller than those of other commonly assayed organisms; moreover, members of the desirable salmonid family are generally the most sensitive of the fish species.

Aquatic Invertebrates. With the possible exception of a few small-scale research investigations, there has been no monitoring of pesticide levels in aquatic invertebrates in Alberta.

Wildlife. With the exception of some avian species, there is very little monitoring of residues in wildlife in the province. Mercury levels were monitored in some upland game bird species during the late 1960's and early 1970's. CWS has monitored levels of DDE, heptachlor epoxide, dieldrin, and mercury since 1969 in Prairie and Peregrine Falcons and in Richardson's Merlins, as well as levels of dieldrin and heptachlor epoxide in the seed-eating bird species preyed upon by Merlins in their breeding grounds in Alberta. For the past three years the Fish and Wildlife Division has collected remains of shorebirds and waterfowl killed by Penegrine Falcons during spring migration through Alberta for organochlorine analysis.

Occasional investigations, such as a recent investigation of carbofuran levels in ducks feeding on treated fields,are conducted by Alberta Environment.

Experimental Blackfly Control Program. Under the Blackfly Coordinating Committee, residue levels following the release of methoxychlor into the Athabasca River have been analyzed for the past three summers in the water, bedload, aquatic invertebrates, molluscs and fish by CDA Lethbridge, the Freshwater Institute and Alberta Environment.

Some Results from Monitoring Studies

From the above-mentioned studies, it might be asked whether discernible residues have been found in the organisms examined. The few results available are presented below:

Water quality. Levels of the phenoxy herbicides, while reaching only a few parts per billion during the summer at the nine sites sampled by Inland Waters, have been on the increase over the past few years. The organophophates break down rapidly in water into metabolites too numerous to analyze separately (especially when the toxicity and biological significance of these are as yet unknown). Alpha-BHC and gamma-BHC (lindane) residues are present almost constantly in the water, with the alpha-BHC form predominating; the source of the alpha form is not known, but is thought to be either a breakdown product of lindane or a byproduct of manufacture present in technical lindane.[17]

Avian fauna. The Prairie Falcon and Richardson's Merlin are still highly stressed by DDE body residues. A slight decline in DDE residues in eggs of the Prairie Falcon may have begun in 1974. Mercury levels have declined each summer since the ban on mercurial seed dressings. Heptachlor epoxide and/or dieldrin levels are high in Merlins and may be responsible for mortality following times of stress.[18]

While not allowing year-to-year comparison of residues in species, the 1974-76 data on migratory shorebird residues in central Alberta collected by Fish and Wildlife show a continuous high level of dieldrin, DDE, and PCB's particularly in the Franklin's Gull, Coot, and Black-bellied Plover. The

[17] Forbes, M., pers. comm.
[18] Fyfe, 1976.

samples were obtained from individuals which had been actual Peregrine Falcon prey. Small quantities of heptachlor epoxide were often present, and lindane and alpha-BHC were occasionally detected in brain as well as fat and muscle tissue.

Fish. The 1975 analysis of lake trout from Cold Lake showed total levels of DDT and its metabolites to be very high in some tissues (e.g. 63 ppm in the body cavity fat). It is thought that these levels are due to the past use of DDT at the Primrose Lake Air Weapons Range.

Methoxychlor Monitoring Program. Reports from the third year of monitoring are not available. A preliminary report by the Freshwater Institute concluded tentatively that: (1) methoxychlor residues in fish lasted about two weeks, with the highest level found at 9.6 micrograms per gram body weight; (2) large species differences in residue levels occur, with flathead chub accumulating several times more than other species; and (3) fish in the first several kilometers up and downstream from the site of application of methoxychlor received the highest residue levels.[19] No long-term methoxychlor residues were found in bottom sediments or water.[20]

Soil. A soil sampling study by provincial and federal agriculturalists in the irrigation districts of southern Alberta found that, of 179 sites sampled for organochlorine residues, 18% had 0.2 ppm; 28%,0.03 ppm and the remainder less than 0.01 ppm. Aldrin, dieldrin, heptachlor, lindane, chlordane and DDT were the most common residues found.[21]

Future Programs

The CWS Toxichemicals Section in Edmonton, under Dr. D. Lane, is presently hiring a research PhD and technician to conduct a long-term study of the flow of some currently used pesticides through a complex prairie ecosystem. The study will begin in 1977 and is expected to involve work in several of the three prairie provinces (locations and pesticides to be studied have not yet been decided).

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[19] Lockhart et al., In press.
[20] Alberta Agriculture, "Agri-News", May 17, 1976.
[21] Ibid., Aug. 15, 1975.

CWS Toxic Chemicals Division, Ottawa

The Division, headed by D. Peakall, is set up to conduct pesticide and other toxicant-related field and laboratory research. Current projects undertaken include a study of the effects of pesticides and polychlorinated biphenyls on development in the Herring Gull and Ring Dove (G. Fox and A. Gilbert), a study of shell thickness in the Lake Ontario population of the Black-crowned Night Heron (I. Price) and monitoring of DDE in birds of prey (D. Peakall). The Division has established a tissue bank for the purpose of storing plant, soil and animal tissues for later pesticide analysis. Contributions will be solicited from wildlife agencies across the country (specifications of tissues and means of shipping are presently being worked out and communications regarding this should be forthcoming soon from J. Learning of the Division).

SOME EFFECTS OF PESTICIDES USED IN ALBERTA ON NON-TARGET ORGANISMS

General Effects

From one point of view, the lack of pesticide residue monitoring in the province is understandable, in that pesticide levels in the body tissue and environment are at present uninterpretable except when approaching the known lethal levels in test species. For many wildlife species, even these lethal levels are not known. Levels at which sublethal changes occur have been delineated in only a few cases.

A general discussion of undesirable effects of toxic chemicals can fall into the following categories:

I. At the level of the organism
   A. Lethal toxicity
      1. Acute
      2. Chronic
      3. "Delayed"
   B. Sublethal Alterations
      1. Genetic
      2. Reproductive
      3. Biochemical, Physiological
      4. Behavioural

II. At the population or ecosysytem level
   A. Biomagnification
   B. Alteration of population or ecosystem

Some general definitions and factors involved in these effects are described briefly below.

I. At the Level of the Organism

A. Lethal toxicity

1. Acute

For non-aquatic organisms, the dosage resulting in the death of 50% of the individuals tested is known as the LD_{50} (lethal $dose_{50}$) and is usually determined by administration of a single oral dose. It is expressed as mg pesticide per kg body weight (usually fresh weight when animals are being assayed). Dermal, intraperitoneal and other methods of exposure are occasionally assayed, in which case the route of administration is specified.

To give a general idea of the potency of LD_{50} values, the following dosages correspond to the LD_{50} values for an average-sized human adult:[1]

LD_{50} (mg/kg body weight)	Dose
5	few drops
50	1 teaspoonful
500	2 tablespoonfuls
5,000	500 ml
15,000	1,000 ml

LD_{50} values are useful for comparing the toxicities of different chemicals or of the same chemical to different species. Table 2 gives the oral and dermal LD_{50} values of some organophosphate pesticides (when the test species is not designated, as in this instance, one can assume it is the laboratory rat). No magic formula exists by which one can compute the dosage level (dermal or other) likely to be encountered by an individual during field application of a pesticide. To obtain a rough estimate of what a lethal rate of application of a certain pesticide in the field might be, it has been suggested that the ratio of the LD_{50} of the pesticide in question to the LD_{50} of another pesticide whose lethal field application rate is known, be applied to that field rate; i.e. for pesticides X and Y:

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[1] Health and Welfare Canada, 1975.

Table 2: Acute Toxicity (LD_{50}) Of Some Commonly Used Pesticides* (mg/kg body weight)

Pesticide	Rat Oral	Rat Dermal	Mallard	Other
Abate	2,200	1,300 (rabbit)	80-100	50 (pigeon); >2,000 (bullfrog)
azinphos-methyl (Guthion)	16	220	136	highly toxic to bees
bromoxynil	190			63 (guinea pig)
captan	8,400-12,000			250 (sheep)
carbaryl (Sevin)	450	>2,000 (rabbit)	2,179	780-1,700 (Sharptail grouse); 200-400 (mule deer)
carbofuran (Furadan)	10		0.397	885 (rabbit); 4.2 (pheasant)
chlorpyrifos (Dursban)	151		75	17 (pheasant); 400 (bullfrog)
2, 4-D (technical acid)	375		1,000	400-800 (mule deer); 472 (pheasant)
2, 4-D (technical sodium salt)			2,025	
2, 4-D (4 lb. acid equivalent per gal. of the amine)			2,000	
demeton (Systox)	2.5	8.2		
diazinon	76	455	3.5	2,000 (bullfrog); highly toxic to bees
dichlorvos (Vapona)	56	75	7.8	
dimethoate	215	1,000 (guinea pig)	41.7	200 (mule deer)
diquat	231		564	
endosulfan (thiodan)	18	74	33	
fenthion (Baytex)	230	320	5.9	highly toxic to bees
lannate (methomyl)	20	1,500 (rabbit)	15.9	15.4 (pheasant) 11-22 (mule deer); toxic to bees
lindane	88	900	>2,000	
malathion	1,000	4,444	1,485	highly toxic to bees
methoxychlor	6,000		>2,000	
parathion	3.6	6.8	2	22-44 (mule deer)
picloram (Tordon)	>8,000		>2,000	
propoxur (Baygon)	100	1,000	11.9	100-350 (mule deer); highly toxic to honey bees
pyrethrum	200	>1,800	10,000	
rotenone			>2,000	highly toxic to swine
trifluralin (Treflan) (mouse)	5,000	>2,000 (rabbit)	>2,000	

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* Compiled from several sources, including Tucker and Crabtree (1970), and U.S. Dept. Health and Welfare ([illegible]) and Agriculture Canada (1973).

$$\text{lethal rate of application}_{(X)} = \frac{LD_{50(X)}}{LD_{50(Y)}} \times \text{lethal rate of application (Y).}$$

However, this information is seldom known for the species in question and the assumption that the two pesticides would act the same in the field is dubious.

Toxicity for aquatic organisms is measured in LC_{50} values (lethal concentration $_{50}$ of the chemical in the aqueous environment) and expressed as either micrograms of pesticide per liter of water or parts per million (ppm roughly = mg/l). LC_{50} assays usually last 24, 48, or 96 hours, during which time no food is given. Most toxicity data have been obtained from static assay systems, as opposed to continous-flow or replenished systems, which are more costly but avoid such problems as waste accumulation, adsorption of pesticide to the tank surface, pesticide volatilization from the air-water interface and other problems which may occur in static systems.[2]

LC_{50} values are more directly applicable to field situations than LD_{50} values, although actual time of exposure may be difficult to estimate. As is evident in Figure 6, 96-hour LC_{50} values for fish are often 50% lower than 24-hour values. Length of exposure is even more important in aquatic invertebrates than in fish, 96-hour values often being one-tenth of 24-hour values .

2. Chronic

Chronic feeding tests usually last for 30 or more days, during which time ad libitum feeding is allowed. This situation may be more similar to field conditions than shorter durations, depending on the persistence of the pesticide in the environment; nevertheless, many factors may still differ greatly between field and lab, such as degree of stress, diet, amount consumed, etc.

3. Delayed

In recent years numerous instances of death attributable to high levels of pesticide in the brain have been documented. It has been found that persistent

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[2] Holden, in Edwards, 1973.

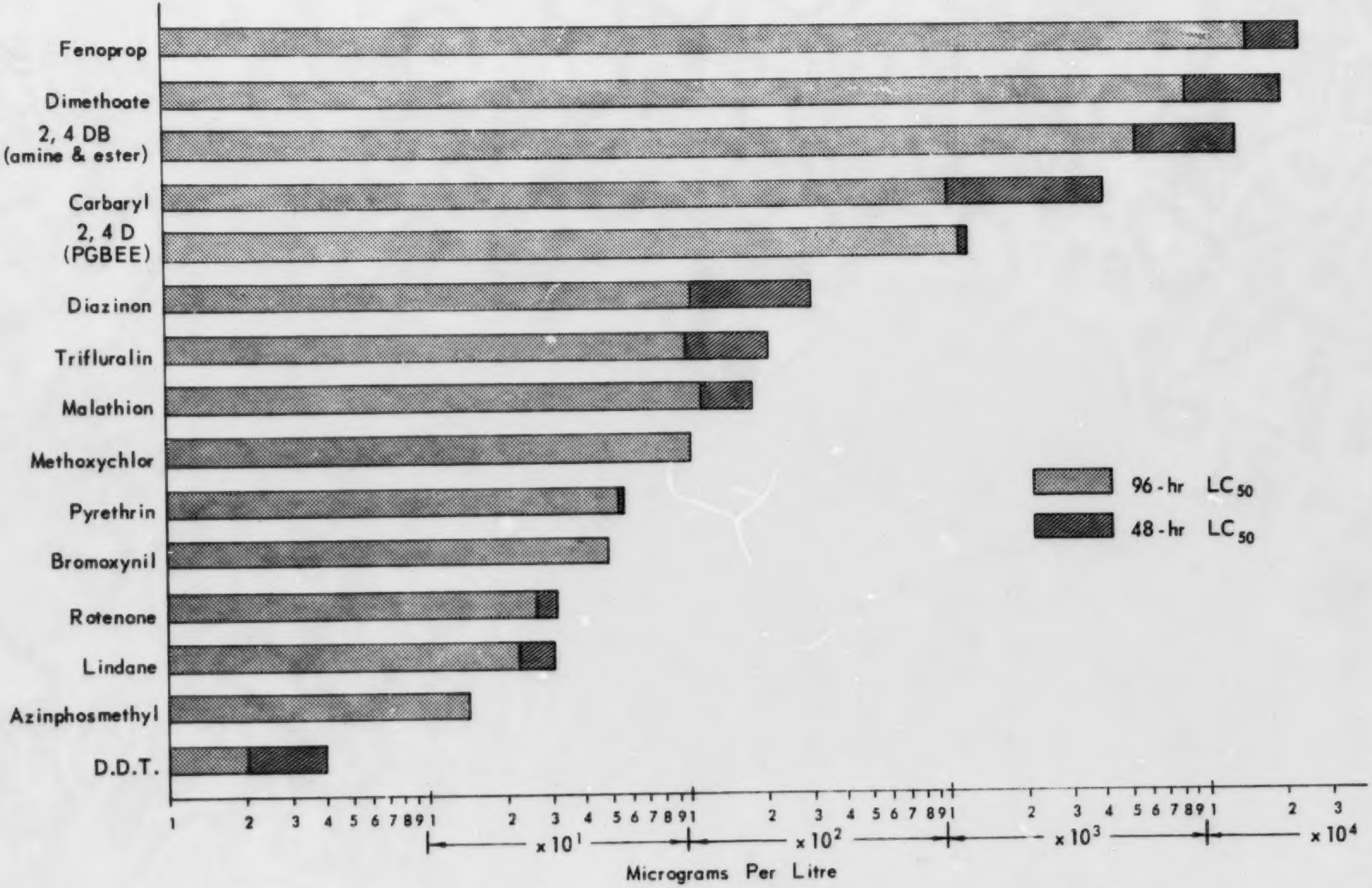

Figure 6 Toxicity of Some Herbicides and Insecticides to Rainbow Trout (LC_{50} at 55°F).

organochlorine pesticides, normally stored in the fat tissue, become mobilized during metabolically stressful times (such as migration), entering the brain and causing death if in sufficient quantity. Organisms for which this has been documented include: the domestic chicken, the Common Murre[3], the Blue and Snow Goose[4], Richardson's Merlin[5], metamorphosizing insects[6], an unspecified fish species in New Brunswick[7], and the Mexican free-tailed bat[8]; the pesticides involved include dieldrin, DDT and DDE. Whether the widely used organochlorine lindane, which is stored to some degree in the body tissue and is present in small amounts in the brain of some birds in Alberta (Section VI),could cause delayed mortality is not known.

B. Sublethal alterations

1. Genetic

The mutagenic hazard of some pesticides was discussed briefly in regard to human health. It is generally held that the hazard to natural populations is negligible due to operation of selective processes which tend to eliminate individuals that possess detrimental mutations.

2. Reproductive

(a) Teratogenicity - Biochemical lesions in the developing embryo do not usually reflect alteration of genetic material; it may be, as some researchers maintain, that sufficiently high doses of otherwise harmless substances can be teratogenic. Nevertheless, some ingredients in pest control products have been shown to be teratogenic at doses to which animals might be exposed. The chlorinated dibenzo-p-dioxin contaminant of silvex, 2,4,5-T and pentachlorophenol was shown to be teratogenic in some species; however, this contaminant has now been reduced to 0.1 ppm, a safe level, according to the Health Protection Branch.

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[3] Scott et al., 1975.
[4] McIntyre and Mills, 1975.
[5] Fyfe, 1976.
[6] McIntyre and Mills, 1975.
[7] Holden, in Edwards, 1973.
[8] Geluso et al., 1976.

In wildlife populations, teratogenicity may result in increased fetal mortality, deformed young and decreased survival of young. Sublethal dosages of methoxychlor and lindane are reported to have caused abortion in mosquito fish.[9]

(b) Eggshell thinning - Laboratory studies have conclusively demonstrated the causal role of DDE on eggshell thinning and ultrastructural alteration in the Mallard, Black Duck, American Kestrel and Screech Owl.[10] In Alberta the Brown Pelican, Peregrine Falcon and Prairie Falcon population are in trouble because of this. Of the pesticides in use today, thiram has been accused but not conclusively demonstrated to cause eggshell thinning.[11]

(c) Other - Delay in reproduction (4 weeks in cotton rats exposed to 1 lb/acre of carbaryl[12]), and decline in hatching rate should be looked for where relevant.

3. Biochemical, physiological

These effects are too numerous to describe here and will be discussed under the appropriate pesticide groups below. However, a few phenomena should be mentioned here.

(a) Detoxification - The induction of the liver microsomal enzymes responsible for the detoxification of many pesticides is a characteristic response to foreign substances in vertebrates. Detoxifying enzymes of similar nature also exist in many or all invertebrates. In the case of some of the organophosphates, enzymatic action in the body has the effect of converting the chemical to a more toxic form.

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[9] Pimental, 1971.
[10] McIntyre and Mills, 1975.
[11] Pimental, 1971.
[12] Stickel, in McIntyre and Mills, 1975.

(b) Interaction of pesticides ("potentiation" effect). In laboratory studies employing relatively high dosages, certain pairs of organophosphates have been found to have a toxicity greater than expected from the sum of their individual toxicities. For example, malathion and EPN together have a toxicity 50 times that which would be expected. One of the insecticide pair is thought to inhibit the enzymes which would otherwise have detoxified the second.[13] Dimethoate with EPN, dichlorvos (Vapona) with malathion, and Abate with malathion also show this effect (in the last-mentioned pair, potentiation is 4-fold in the chicken[14]). Apparently, species differ considerably in degree of potentiation[15], but given the state of knowledge regarding comparative metabolism, this difference is not presently explicable.

(c) Bioaccumulation - Accumulation of any foreign chemical in the body tissue occurs when the sum of intake (via the respiratory surface and/or food supply) exceeds the rate of excretion, flushing away, and/or metabolic breakdown of the chemical. (Aquatic vertebrates can simply flush away foreign substances, but only at a very slow rate in the case of lipid-solubles[16]). Thus the phenomenon is not irreversible. A "cumulative toxicity index" (ratio of single oral LD_{50} to the 30-day minimum daily oral dosage required to produce death in 1/6 to 1/3 of the test animals) has been calculated for some pesticides as shown in Table 3.

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[13] U.S. Dept. H.E.W., 1969.
[14] Wolfe *et al.*, in Labisky, in press.
[15] U.S. Dept. H.E.W., 1969.
[16] Matsumura *et al.*, 1972.

Table 3. Cumulative Toxicity Index for Some Pesticides Used in Alberta (from Tucker and Crabtree,1970)

These index values were obtained from feeding studies using Mallard ducks. The values represent the ratio between the single LD_{50} dose and the 30-day minimum lethal dose (i.e. acute LD_{50} ÷ 30-day minimum lethal dose). When compared with the value for DDT, they give an indication of the hazard from long-term exposure.

Pesticide	Index
temephos (Abate)	32-40
propoxur (Baygon)	none
fenthion	11.9
dimethoate	7
chlorpyrifos (Dursban)	>30
DDT	>44.8
carbofuran	slight or none
azinphos-methyl	>16
lindane	>67

4. Behavioral

Documented cases of alteration in behavior of animals exposed to pesticides exist. Dieldrin and DDT have been shown to affect learning and avoidance behavior in sheep and fish, respectively. Sublethal doses of organophosphates, due to their action on the nerves, can cause unnatural behavior in exposed individuals.

II. At the community, population or ecosystem level

A. Biomagnification

Once the bioaccumulation of a chemical at one or more trophic levels of a food web occurs, increasingly higher chemical levels will exist as the trophic levels are ascended, unless (a) intervening trophic levels are capable of eliminating the chemical or (b) additional, uncontaminated food sources constitute a major part of the diet of the species occupying the higher trophic levels.

A short and fast version of food chain poisoning, one which does not involve actual bodily storage of pesticide, can occur with the non-persistent but highly toxic insecticides such as fensulfothion. Such insecticides have been known to kill large numbers of insectivorous birds which are attracted to struggling, poisoned insects in a sprayed area. Even seed-eating species may be attracted to these insects.[17]

A hazard, in theory at least, exists for predators of populations which have become resistant to a pesticide and harbor high body residues of it. For example, in the mosquito fish, resistance to toxaphene, lindane, aldrin and heptachlor has been found.[18] With the present Canadian restrictions on usage, only lindane might still pose a problem to predators of fish. For insectivorous predators, the use of short-lived insecticides has greatly

[17] McIntyre and Mills, 1975.

[18] Culley and Ferguson, 1969, in Edwards, 1973.

diminished this danger.

B. Alteration of Population or Ecosystem

The greatest hazards from pesticides result from macrosystem effects; however, studies involving entire ecosystems are few. In most cases, effects at the community or population level are just beginning to be described.

1. Emigration of Wildlife

In bird population studies before and after spraying of insecticide, emigration has sometimes been found to occur.[19] Temporary emigration during breeding season is, of course, likely to result in loss of young; and second nesting attempts are in general much less successful than first ones.[20] Furthermore, displaced adults of any species are at great risk when seeking new territory.

The alteration of vegetative communities by herbicides will also result in alteration of faunal composition, and can be to the benefit or to the detriment of wildlife. In the latter case, displaced individuals can be assumed to undergo a high mortality rate.

2. Simplification of vegetative communities

The simplification of vegetative communities by herbicides may result in less resistance to external stresses such as drought, pests and erosion (for example, see Effects of Picloram below).

3. Effects of insecticides on insect communities

The repeated use of insecticides over large areas has in some instances back-fired. Approximately 230 insect species are known to be resistant to various insecticides (often to entire classes of insecticide) and in some of these cases the pesticides appear to exert a stimulatory effect on pest reproduction.[21] Whether stimulatory or simply ineffective, the spruce budworm insecticiding program, which began in a small area in New Brunswick in 1952 and expanded steadily to include the entire province by 1976, has been accompanied by an expansion of the infestation, which covers the entire province as well as parts of other provinces today.

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[19] MacEwen *et al.*, 1971.

[20] *Ibid.*

In some instances, insecticides have created new pests (for example, the red spider mite) by destroying non-target predator species. Furthermore, they can hinder insect predators of pests in a number of indirect ways, by decreasing the species which supply the predators with subsidiary foods (e.g. honeydew), poisoning the subsidiary food supply, and destroying alternate hosts of predators.

4. Effects on soil organisms

The microflora and fauna of the soil affect plant growth, soil fertility, and higher organisms in diverse ways; the effects of many pesticides on these have not been investigated. A 1974 CDA study lists the following as important, still required information: "the effects of seed treatment fungicides on soil fauna; of lindane, dasanit (fensulfothion), furadan (carbofuran), and lannate (methomyl) insecticides on fungi, bacteria, and actinomycetes; of lindane and diazinon on nematodes; and of dasanit, furadan, and lannate on earthworms, enchytraeid worms, Collembola, and mites. Also, more information is needed on the effects of barban, diallate, and triallate herbicides on the major soil biota and MCPA on the soil fauna."[22]

Specific Effects

The following section attempts to focus on potential ecological problems resulting from specific pesticides used in Alberta and is based on the available literature and interviews with authorities. It makes no claim to be exhaustive and, due to the nature of the literature surveyed, may cite studies showing detrimental effects while ignoring studies reporting no detrimental effects. Some of the concerns delineated may prove to be false alarms; nevertheless, a compilation of potential problems is a necessary first step in the formation of research needs.

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[21] J. Muldrew, Northern Forest Res. Center, seminar, Dec., 1976.
[22] Mills *et al.*, 1973.

Mosquito Control

Adulticiding of mosquitoes is held to be a last resort by the interdepartmental Alberta Mosquito Control Committee. Until the ecological ramifications of this practice are elucidated, it should be regarded as potentially detrimental. A current study of the effect of ultra low volume spraying of malathion in the City of Edmonton has shown that active insects of many species are killed, while inactive individuals survive; the toxicity may depend on metabolic rate. In June and July, many beneficial species which feed on the eggs of other insect species are active; hence there is a possibility that adulticiding at this time could lead to outbreaks of mosquitoes or other pests.[23]

Availability of insects is critical for survival of young birds, even for those species which are not insectivorous in adulthood. Whether the spraying of insecticides has an effect on their survival is not known and is presently under study by the City of Edmonton. Temporary emigration of birds from an area sprayed with malathion has been found in several other studies.[24] [25] If this were to occur during nesting, survival of young would be affected. As mentioned previously, emigration can always be assumed to result in mortality to some individuals. Malathion spraying has also been stated to cause hemorrhaging, cyanosis, and decreased circulation in exposed embryos and limb abnormalities in 16-day-old chick embryos exposed to usual rates of application.[26]

With the great quantity of this chemical used in Alberta for various insect pests (12,000 lbs. applied by licensed applicators in 1975), further information on this effect is needed. Whether secondary poisoning of birds attracted to struggling insects occurs should also be studied.

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[23] Griffiths, G. (unpublished).
[24] Wolfe (cited in Labisky, in press).
[25] MacEwan *et al.*, 19 .
[26] Abbott *et al.*, (cited in Somers, 1972).

The larvicides presently recommended by the Mosquito Control Committee for use in Alberta are the organophosphates Abate (temephos), malathion, Dursban (chlorpyifos) and the organochlorine methoxychlor.

Fenthion (Baytex) is no longer recommended by the Committee, although it is still available (Schedule D). It has a high dietary toxicity for some birds (e.g. Mallard, Bobwhite)[27] and at normal rates of application is toxic to dragonfly nymphs[28] (a mosquito predator species), chironomid larvae and (in shallow water) to shrimp and amphipods. Its reported use by licensed applicators in 1975 was very low or nil; however, it may be employed on waterbodies on private land, in which case it may be hazardous to waterfowl, shorebirds and other species nesting nearby.

Dursban received extensive use in the province in 1975. At normal application rates it is lethal to some species of fish and to most or all aquatic insects.[30] Crustaceans may also be killed at normal concentrations.[31] The Mosquito Control Committee states that it should not be applied to "impounded water containing valuable fish."

The cumulative dietary toxicity of Dursban (as judged by 30-day feeding studies) for Mallards is very high for an organophosphate (<2.5 mg/kg/da); in survivors the chemical was associated with "gross pathological changes"[32]. The chemical is more stable on surfaces than many others of its type (for example, it remained effective against houseflies on treated wooden surfaces for about 40 days). Whether herbivorious (e.g. berry-eating) birds in treated areas could accumulate enough to cause ill effects is unknown and should be investigated.

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[27] U.S.D.I., 1972.
[28] Hudson, 1973.
[29] Macek *et al.*, 1972.
[30] Morre and Breeland, 1967 (cited in Hudson, 1973).
[31] Ludwig *et al.*, 1968.
[32] Tucker and Crabtree, 1970.

Approximately 650 lbs. of Abate were applied by licensed applicators in 1975. Abate is toxic to passerine species (8-day ad libitum feeding of pesticide-treated food resulted in LC_{50}'s in the <30-75 ppm range for Blue Jays, Cardinals and House Sparrows.[33] Thus, the possibility of secondary poisoning to insectivorous passerines (and especially young) deserves attention. It is less toxic to game birds. Abate at normal rates can kill caddisfly larvae and odonates (dragonflies); contradictory results have been reported with other aquatic invertebrates.[34]

The potential effects of methoxychlor are discussed below It is not permitted as a mosquito control chemical on "water containing valuable fish."

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[33] Hill, 1971.

[34] Hudson, 1973.

Aquatic Herbicides

In general, removal of aquatic vegetation from ponds and lakes can have numerous detrimental ramifications, such as:

-- depletion of dissolved oxygen content due to microbial decomposition of killed weeds;

-- proliferation of blue-green algae due to increased nutrient levels during decomposition of aquatic macrophytes: these nuisance algae are not utilized by many aquatic faunal species and are toxic to some types of fish;[35]

-- proliferation of submersed weeds (generally more objectionable and harder to control) following removal of water-shading surface plants;

-- destruction of shoreline vegetation which in early summer provides habitat for spawning northern pike[36] and nesting waterfowl;

-- decrease in those invertebrates which require aquatic vegetation (snails, aquatic insects) and subsequent effect on higher trophic levels.

In addition, specific problems may arise from use of certain herbicides.

Paraquat : diquat

Two studies of the effects of a 1.0 ppm mixture of diquat and paraquat (1:1) in Lake Wabamun have identified some actual and potential ecological effects of this mixture, which resulted in the drastic reduction of certain species of zooplankton and macroinvertebrate fauna (including chironomids, gastropods and amphipods).[37] While reduction in the macroinvertebrates was thought to reflect their emigration from the treated area, the possibility exists that treatment of an entire body of water could result in their mortality and concomitant stress to trout, whitefish, pike fry and other fish whose diet depends in large part on these organisms. This possibility should be tested, beginning with a simple assay of these herbicides on macroinvertebrate species.

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[35] Alberta Environment, 1973.

[36] Gallup *et al*., 1973.

[37] Gallup *et al*., 1973.

Simazine

This herbicide accumulates in algae and daphnia and, as a result, in carp;[38] it also is taken up in considerable amount in aquatic vascular plants.[39] In bottom muck, it was found at 180% of the applied concentration four days after application to water.[40] Whether biomagnification or secondary poisoning of waterfowl, fish and semi-aquatic furbearing species can occur should be examined.

Silvex (fenoprop)

This relative of 2,4,5-T may contain up to 0.1 ppm of the dioxin contaminant TCDD (see above).[41] While such a concentration appears miniscule, bioaccumulation of this teratogenic substance is known to occur in algae, snails and fish.[42]

[38] Maier - Bode, 1972.
[39] Buryy *et al.*, 1973.
[40] Maier - Bode, 1972.
[41] Switzer, A., pers. comm.
[42] Dow Chemical of Canada, in E.C.A. vol. 6 p. 524, 1975.

Blackfly Larviciding with Methoxychlor

Until the final analysis of the experimental blackfly control program studies on the Athabasca River are available, the ecological problems suggested in the report, "Methoxychlor: Its Effects on Environmental Quality"[43] should be kept in view. These are summarized briefly below.

Bioaccumulation: The concentration factor in fish was found to be 40 - 1500 (vs. 84,000 for DDT); in the water snail Physa, 2,600; in Daphnia, 2,200. Thus a potential hazard to higher trophic levels appears to exist. Secondary poisoning or bioaccumulation in individuals ingesting poisoned insects may occur.

Toxicity to fish: Blackfly larviciding doses (10 - 300 micrograms per liter) fall within the range of toxicity to fish. Long-term laboratory studies have demonstrated reversible pathological effects, growth retardation, and inhibition of spawning and hatching in some fish species; the timing between repeated doses may be critical.

Indirect effects on fish: The possibility of food supply depletion for fish should be examined.

Indirect effects on other organisms and populations: Killing of the caddisfly and other natural predators of blackfly larvae could lead to further outbreaks. The effect of methoxychlor on phytoplankton productivity is unknown. Persistence of the chemical in the bedload and sediments is also unknown, as is the complete metabolic degradation pathway. If anaerobic degradation occurs, methoxy-DDE may be a major metabolite.

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[43] N.R.C.C., 1975.

Spraying of Organophosphate Insecticides in Agriculture

Organophosphates are absorbed via the oral, dermal and respiratory routes; effects may be more noticeable in a particular area depending on the route of administration. They are rapidly metabolized and excreted by mammals, and the acute toxic effects from over-exposure, namely irreversible acetylcholinesterase inhibition and associated neurofunction disruption, have been well studied. However, the chronic toxicity which is occasionally observed with these pesticides has not been fully elucidated. It is thought that chronic toxicity reflects the gradual build-up of irreversible effects, rather than accumulation of a metabolite of the chemical itself.[44] Chronic poisoning has been found in cattle exposed to continuous inhalation of phorate (Thimet) from contaminated soil.[45] Whether repeated exposure to any of the aerially applied organophosphates (such as azinphos-methyl [Guthion], diazinon, dimethoate, demeton (Systox), leptophos [Phosvel] could result in chronic poisoning to birds or other wildlife is not known but deserves further study.

Azinphos-methyl, with an LD_{50} of 16.4 in rats; demeton, with an LD_{50} of <10 in rats; and diazinon, with and LD_{50} of 3.5 in Mallards, may pose some danger of secondary poisoning to insectivorous birds and rodents. A study of the effects of ultra low volume spraying of azinphos-methyl at 4.0 oz a.i. per acre (a standard rate) found high initial residues in sparrows as well as grasshoppers.[46] More work is needed to determine whether there is any problem in this regard.

Dimethoate is stated to be "moderately cumulative" in Mallards.[47] Widely used in the province for grasshoppers in alfalfa, clover and cereals and aphids in rape and flax, this chemical should be studied with regard to cumulative toxicity to insectivorous birds (including young).

[44] Khan, 1973.
[45] Pugh, 1975.
[46] McEwen *et al.*, 1971.
[47] Pimental, 1971.

Other Agricultural Insecticides

Carbofuran

This chemical, used as a spray for grasshoppers in alfalfa, cereals, oilseeds and corn and as a granular formulation for flea beetles in rape, has a half-life in soil of 4 - 54 weeks, depending partly on soil pH.[48] With an LD_{50} of 14 mg/kg for Mallards, it presents a strong potential for acute toxicity in ducks and perhaps other avian species foraging in treated crops. In California, it is reputed to have caused the death of 2,450 Widgeons in alfalfa fields.[49] Several cases of duck mortality in B.C. have been attributed to the 10% granular formulation on a clay carrier base, which was found in the crops of the dead individuals.[50] In Alberta, a 5% granular formulation on a corn cob base is used; this is sown with the seed and is biodegradable, unlike the clay base.

In laboratory studies, carbofuran at 1 ppm caused "intoxication" in Fulvous Tree Ducks and mortality at 2 ppm for 7 days.[51] However, a study of a slough near Purple Springs, Alberta, sprayed with the normal rate for grasshoppers, detected no carbofuran or 3-OH-carbofuran in soil, water or bottom mud.[52] At 0.5 ppm in alkaline water (pH 9.0) the carbofuran was found to disappear at room temperature within one hour.

Carbofuran is highly toxic to earthworms and bees.

Its potential for extensive use in the southern part of the province warrants further study of its toxicity in the field, especially with regard to direct toxicity to avian species and indirect toxicity via earthworms and other insects.

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[48] Getzin, 1973.
[49] McIntyre and Mills, 1973.
[50] C.W.S., 1975.
[51] Tucker and Crabtree, 1970.
[52] H. Block, pers. comm.

Endosulfan (Thiodan)

Endosulfan is recommended for Colorado potato beetle and various aphids. In 1975, 192 lbs. were reportedly applied by licensed applicators. More than 50% of it persists for over two years in the soil. Evidence suggests that it may occur in run-off water, and several fish kills have been associated with its use in Canada.[53] More information is needed regarding its residues in aquatic systems, particularly the formation of endosulfan sulfate, a substance quite toxic to some aquatic organisms and persistance. (It is known that the two active isomers present in endosulfan disappear in water by four weeks and are replaced by a new compound as seen by gas chromatography).[54]

Lindane

This broad spectrum chlorinated hydrocarbon insecticide is now coming into very wide use as a replacement for heptachlor, dieldrin and aldrin in seed treatment. Gamma-BHC, the main component of lindane and a partial component of industrial BHC, has been found in birds in the U.S. in the 0.05 - 1.5 ppm range[55] and in wildfowl eggs in East Germany at 0.69 ppm.[56] It has been detected in trace - 0.003 ppm in migratory waterfowl and shorebirds killed by Peregrine Falcons in Alberta. Lindane has also been found in crops of wild pheasants (although apparently pheasants in force-feeding studies will not eat the treated seed).

The accumulation of lindane in the body is less than that for DDT, heptachlor, and dieldrin. Accumulation is dose-related but also is reputed to cause an increase in the body storage of DDT (the latter is still a hazard for these North American bird species which spend part of the year in Latin America).[57]

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[53] Agricultural Pest Soc., 1975.
[54] Nichelberger and Lichtenberg, 1971.
[55] Henderson *et al.*, 1969 (cited in Edwards, 1973).
[56] Jung *et al.*, 1971.
[57] Stickel *in* Edwards, 1973.

Use of lindane powder in poultry houses and on poultry results in residues in eggs.[58]

The extent to which lindane may be accumulated in seed-eating species under the new patterns of use should be investigated. If this proves significant, potential ability to cause the "delayed mortality" phenomenon following stress should be determined.

Chlordane

While the present limited usage of chlordane in the province is not expected to cause ecological damage, the potential for wider usage of this chemical is the reason for its inclusion here. Chlordane has been under review by Agriculture Canada since 1974; if changes in its registered uses are to be made, they will not go into effect until 1978. According to Alberta Environment, (after this had been written) chlordane will likely be phased out in the near future. In Alberta, chlordane is used for wireworms in potatoes (for which it is broadcast on the surface and use recommended not more than once every four years) and domestically for cutworms in garden crops and cockroaches and termites in buildings.

According to the NRCC report "Chlordane: Its Effects on Canadian Ecosystems and Its Chemistry," technical chlordane is a mixture of seven chlorinated hydrocarbons - cis- and trans-chlordane, heptachlor, nonachlor, and three chlordene isomers. All seven persist in the soil up to 10 - 14 years in Canadian climate (as opposed to warmer climates). Fifty percent of the chlordane disappears in the first year; the fate of the persistent remainder is poorly known. The compounds have low solubility in water and residues remain in the topsoil and do not leach.

Information is lacking on the effects of the components of chlordane on soil invertebrates. Several of the components apparently bioaccumulate in earthworms approximately 200-fold. This necessitates study of the soil -

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[58] *Ibid*.

invertebrate - vertebrate food chain. The NRCC report further stresses the need for determining the fate of the heptachlor component, which comprises about 7% of technical chlordane. Heptachlor has been suspended for use in Canada (and the U.S.) because of the bioaccumulation of heptachlor and its breakdown product, heptachlor epoxide, in many organisms.

Once in aquatic ecosystems, chlordane accumulates in bottom sediments. The extent to which it can enter an aquatic system after application to soil has not been determined. Chronic exposure studies on aquatic organisms have been hampered and are in many cases misleading due to its strong adhesion to aquarium walls.

The method for identifying all the components of chlordane in residue samples has not yet been standardized.

Fungicides

Thiram

This extensively used seed dressing may have detrimental effects in birds; when fed to chickens it can cause abnormally-shaped and soft-shelled eggs.[59] Also, egg production was found to cease when hens were fed either (a) 1/100 of the LD_{50} for 6 days or (b) 1/200 of the LD_{50} for 90 days.[60] Licenced applicators applied 6,000 lbs. of thiram in 1975. According to recent information from Alberta Environment, thiram will soon be withdrawn from the Canadian market. Its presence in and effect on eggs of game birds and other granivorous species should be monitored.

Captan

Captan reacts with free thiol groups in biological tissue and its ability to damage chromosomes is treated in Appendix A1. Studies on its possible teratogenic effects are contradictory in hamster, rabbit and Rhesus monkey.[61] While it is of very low toxicity to birds and mammals, its toxicity to rats has been found to increase 2,000-fold when the animals are on a diet consisting of 1/3 of their required protein.[62] Whether this could be detrimental to wildlife species under nutritional stress should be investigated. In a model aquatic ecosystem, captan left small amounts of an unidentified compound in snail, fish and algae.[63]

Pentachlorophenol

A popular wood preservative, pentachlorophenol was reputedly contaminated with "significant" amounts of dioxin in 1973.[64] However, Plant Products Div.

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[59] Pimental, 1971
[60] Zhavoronkov et al., 1973.
[61] U.S. Environmental Protection Agency, 1975.
[62] Boyd, 1972.
[63] Sanborn, 1973.
[64] E.C.A., 1974, Info. Bull. no. 4

Ottawa, have found no more than 2-6 ppb of the dioxin contaminant TCDD in supplies sampled from Alberta. Pentachlorophenol is now used in pulp mills as a replacement for mercurial fungicides. It is reputed to impair energy metabolism in some species of fish,[65] and its use on wooden bridge pylons should be examined.

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[65] Kerr and Vass, in Edwards. 1973.

Roadside Herbiciding

In 1973 (the last year for which figures have been published) 42,568 miles of roadside were sprayed with herbicides by municipalities in the province.[66] The chemicals used for this combination weed, shrub and tree destruction are 2,4-D, 2,4,5-T, picloram (Tordon) and MCPA. Spraying is conducted for the purposes of enhancing snow removal efforts, preventing snow accumulation on roads, destroying noxious weeds, protecting powerlines, and improving visibilty.

With the present agricultural practice of clearing farmland by bulldozer, roadside vegetation is becoming an increasingly important habitat for upland game birds, certain songbird species, and small mammal species such as snowshoe hare and ermine. The rationale behind the destruction of this public land habitat deserves closer scrutiny.

a) Prevention of snow accumulation on roads. Snowplows need a roadside free of dense shrubs and trees between the road and the ditch in order to move snow far enough from the road so that it does not cause further accumulation. However, there remains about 14 feet between the ditch and fenceline. A study in central Alberta of snow accumulation cause by roadside vegetation concluded that vegetation does not always result in snow accumulation on minor roads.[67] The report sets forth the following "rules" which were found to govern this accumulation:

-- Vegetation on the side of the road that is leeward of winter storm directions is not responsible for snow accumulation on roads;

-- On the windward side, a dense shelterbelt or stand of trees between the field and fenceline will stop snow drifting before it reaches the road, irregardless of whether the road allowance is vegetated or not;

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[66] Municipal Agricultural Service Board Annual Report, 1973.
[67] E.C.A., 1976.

-- In the case of a bare field bordered by a vegetated road allowance, snow accumulation on the road will not result if trees are thinly spaced or shrubs are low enough to become buried early in winter (This is not to say that snow accumulation never occurs in these cases, but simply that it is not caused by the roadside vegetation in these cases).

b) Destruction of noxious weeds. Herbiciding of weeds has been reputed by numerous sources to result in a self-perpetuating cycle of weed destruction followed by colonization by grass and annual pioneer weed species and further spraying.[68] Such a use of herbicides is contrary to the philosophy set forth by the Canada Weed Committee in 1973, namely, the minimization of chemical herbicide use.[69] Some municipalities carry out backsloping (when necessary) and seeding to grass or grass-legume mixtures. This practice is said to be more costly than spraying.

Where roadside vegetation is allowed to undergo succession, shrub communities that remain stable for decades often predominate, to the detriment of annual weeds and the benefit of wildlife.

c) Chemical destruction of roadside trees. A forestry publication points out that herbiciding of trees results in various stages of destruction of those trees on the periphery of the sprayed zone (as in the case of roadsides where trees are sprayed adjacent to a shelterbelt or stand within the fenceline). Upon examination, many of these weakened trees have been found to harbor pathogenic fungi, which could spread and cause "extensive damage" when stands are subjected to another stress, such as drought.

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[68] for example, see E.C.A., 1975, Vol. 1, p. 138.
[69] Canada Weed Committee, 1973.

d) *Effects of the chemicals used*. Apart from the possible mutagenicity of 2,4-D (Appendix A1), the possibility of teratogenic or toxic effects of 2,4-D spraying on avian embryos, has been examined. One study utilized eggs of several game bird species, including Grey Partridge (*Perdrix perdrix*) and Ring-necked Pheasant.[70] Spraying the eggs with the amine salt of 2,4-D at 7-16 oz/acre resulted in the death before hatching of 155 out of 201 Grey Partridge and 399 out of 520 Ring-necked Pheasant embryos. Many of the survivors were paralyzed and had other abnormalities. However, in direct contradiciton to this are the results of a second study which found no adverse effects after spraying eggs of Ring-necked Pheasant and domestic chicken with the amine of 2,4-D at 2.5 and 25 lb/acre.[71]

The palatability of certain plants which are poisonous to livestock is reportedly increased by application of 2,4-D. Alberta Agriculture advises that grazing not be permitted for at least one week after application for this reason. *The significance of this effect on herbivorous wildlife species likely to be in contact with sprayed foliage should be investigated*.

The entrance of phenoxy herbicides into sloughs and marshes via ditch water may have consequences on aquatic flora and fauna. The existence of 2,4-D in prairie sloughs has been found to be significantly correlated with an abnormal aquatic invertebrate and plant species composition which could have repercussions on higher aquatic trophic levels such as waterfowl.[72] Vegetation at the water's edge might also be reduced, resulting in loss of nesting habitat for waterfowl. Picloram is highly water-soluble and would be expected to enter wetlands via ditch water. *The effect of picloram on* aquatic ecosystems has received little investigation. The toxicity of these herbicides to fish varies according to formulation and chemical formula: 2,4-D LC_{50}'s range from 0.9 mg/l (acid equivalent, the isopropyl ester) to 900 mg/l (the alkanolamine). The isooctyl ester of picloram is the most toxic of its formulations, at 1 mg/l.

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[70] Lutz-Ostertag and Lutz, 1970.

[71] Somers *et al*., 1973.

[72] J. Patterson, pers. comm.

According to the manufacturer, if the dioxin contaminant of 2,4,5-T were to reach aquatic systems, a problem of biomagnification could occur.[73] This highly toxic, teratogenic substance is applied at the concentration of only 50 micrograms per acre at normal application rates[74], but requires one to two years to degrade, remaining on the foliar surface until washed off by rain. It absorbs strongly to soil.

Either water or diesel fuel oil can be used as a carrier with 2,4-D, although water is less effective. Diesel fuel oil has been demonstrated to cause mortality in unhatched avian embryos.[75] It is the carrier used on the Central and Northern Grazing Reserves in Alberta and also by the Rural Electrification Association in their roadside spraying.

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[73] Dow Chemical of Canada, in E.C.A. 1975, Vol. VI, p. 517.

[74] Ibid.

[75] Abbott et al., 1964 (cited in Somers, 1972).

Agricultural Herbicides

Paraquat

The bipyridylium herbicides such as paraquat exert effects which are delayed by several days following exposure.[76] Paraquat, with a fairly low toxicity to rats (120 mg paraquat ion/kg), was nevertheless found to kill approximately 50% of the hares placed in a sprayed area several hours after the area had been treated with a "standard dosage" for weed control.[77] Paraquat imparts injury to animals by attacking the lungs, cornea and nasal mucosa;[78] a very small oral dose of the concentrate may produce irreversible lung fibrosis followed by death.[79] It is absorbed through the skin if the skin is wounded.[80] Its effect on small mammals and birds when sprayed on shelterbelts or as part of a soil sterilant mixture should be investigated more thoroughly.

Paraquat may also have an inhibitory effect on many strains of nitrogen-fixing bacteria in soil.[81]

In 1975, 1,390 lbs. of this chemical were applied by licensed applicators. In the future a permit will be required for its purchase (Sched. B).

Hoe-Grass

A new phenoxy herbicide developed by Canadian Hoechst Ltd. for use in wheat (probably available in 1977) has a low dietary toxicity for mammals but exhibits some toxicity via inhalation. Test rabbits exposed to a fine spray (aqueous) of 5% for 4 hours declined to eat and died of starvation. Rats

[76] Kay, 1973.
[77] De Lavaur *et al.*, 1973.
[78] Day, 1973.
[79] Staiff *et al.*, 1975.
[80] Weed Sci. Soc. of Am, 1974.
[81] Manninger *et al.*, 1972.

and guinea pigs exposed to the spray lost weight for several days but recovered. Some metabolites of the chemical were retained in the liver of rats. Reduction of food intake also followed oral administration to pregnant rats. Studies will be needed to assess the possibility of sublethal effects on mammals in field conditions.

With an LC_{50} of 0.2 - 0.4 ppm for fish, Hoe-Grass should also be monitored for uptake by aquatic plants and fish food organisms in order to determine whether there is any hazard to fish in adjacent water bodies.

Spraying of Rangeland with Picloram (Tordon)

Some statements from the NRCC report "Picloram: The Effects of Its Use As a Herbicide on Environmental Quality" are exerpted below:[82]

Herbicides containing picloram are regarded as having considerable potential for the control of woody and herbaceous plants on over-grazed rangelands (Arnold and Santelmann 1966; Scifres and Halifax 1972; Bovey and Scifres 1971). The object is to simplify the plant community by killing brush and herbaceous vegetation and to promote increased grass cover to sustain heavier grazing.

The inherent problem may be in the resultant simplification of the natural ecosystem by possible impairment of stability. Whereas short-term yield is of prime importance in artificially stabilized cropland systems, the concern in native rangelands is for long-term yield. The stability of a complex mixture of plant species may influence the average yield of grasslands over a longer period than is the case with simpler systems (Spedding 1971). The killing of herbaceous plants could possibly, at some dosage rates, result in the loss of legumes, an important nitrogen source to the ecosystem. Furthermore, a diverse rangeland flora may be less susceptible to serious loss from adverse climatic conditions or insect damage (Vallentine 1971). Diversity gives more buffering against drought. A mixture of more or less drought-resistant plant species, with appropriate seasonal growth patterns, may be more productive in the long run than any of the species grown alone (Spedding 1971). The ability of the plant community to withstand drought is of particular importance in western Canadian rangelands where there are frequently successive dry years which reduce the abundance and cover of the higher yielding grasses (Campbell et al., 1962).

There has been relatively little research done on the long-term effects of picloram on desirable species other than grass, in rangeland ecosystems (Scifres and Halifax 1972a). Not only are brush and forbs affected but detrimental effects have also been found on desired rangeland grasses. Gesink et al. (1973) found that picloram + 2,4-D (0.6 kg/ha + 2.2 kg/ha respectively) application to Wyoming rangeland resulted in injury to certain perennial grasses during the first and second years after the herbicides were applied. This response was not observed at lower application rates (0.3 kg/ha picloram; 1.1 kg/ha 2,4-D). However, after five years perennial grass cover on plots treated at the higher rate was greater than that on control plots and plots treated at the lower rates (Gesink et al. 1973).

Arnold and Santleman (1966) treated established native range in Oklahoma with picloram at rates of up to 4.4 kg/ha, which is higher than presently recommended. All rates lowered forb production without reducing desirable grasses. However, pre-emergent treatment with picloram 0.8 kg/ha prevented germination in the greenhouse of side-oats grama (Bouteloua curtipendula), big bluestem (Andropogon gerardi), switchgrass (Panicum virgatum) and blue grama (Bouteloua gracillis) and decreased yields at the two- and four-leaf stages. At advanced growth stages, all species became more resistant to picloram.

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[82] NRCC, 1973, pp 69,70.

According to Bovey et al. (1970) persistence of picloram in soil and the movement of picloram in water are not considered to be objectionable in non-croplands, but are thought to be necessary to arrest regrowth of woody species after the initial defoliation by foliar sprays. However, concern over soil residues following picloram application to rangelands and the sensitivity of some grass seedlings led to a study by Scifres and Halifax (1972a) on root production of seedling grasses in picloram-treated soil. With picloram residues in the soil (500 to 1,000 ug/kg), it was found that foliage of switchgrass was developed at the expense of root production. There was no differential inhibition of side-oats grama roots and shoots, although root penetration was inhibited when picloram was present in the surface inch of soil. Scifres and Halifax (1972a) concluded that picloram, applied just prior to or following range seeding, or applied to badly depleted rangeland, could further complicate the rate of reseeding establishment.

In a subsequent experiment, Scifres and Halifax (1972b) found that picloram differentially regulated post-germination growth of range grass seedlings. Buffalo grass (Buchloe dactyloides), which was the most resistant of five grasses studied, showed significant root length reduction at 125 ug/kg (in soil). Again, with all species, picloram had a greater effect on roots than on shoots.

Since root growth can be differentially affected by picloram, the resistance of treated rangeland ecosystems to grazing and drought could be seriously impaired.

In the future, pictoram will be a Schedule B product (i.e. permit required from a municipality or Environment and availability restricted to farmers and licenced applicators).

Vertebrate Biocides

Strychnine-treated "mouse seed" and grain

Mouse seed is currently available to domestic users in Alberta. According to the Alberta Veterinarian Medical Association, the number of diagnosed animal poisonings due to mouse seed rose steadily from 1971 to 1975 (the majority of cases were dogs); and over the last three years, 25 children per year have also been poisoned by mouse seed. The amount of strychnine recovered from the stomach of one animal was enough to kill "two or more 90-lb German Shepherds"[83].

The poisoning of eight Canada Geese which died in the City of Calgary in 1968 is probably due to the practice by farmers of placing strychnine-treated grain on the surface of the ground surrounding ground squirrel burrows. This practice by farmers will not be curtailed with passage of the new Alberta legislation. Both a primary hazard to granivorous species and a secondary hazard to their predators must result from this usage. Clearly, alternative methods to strychnine are needed.

In the case of treated grain application by means of the burrow-building "Gopher-Getter" machine, an intensive study in Minnesota revealed that 0.5% strychnine-treated milo reduced the pocket gopher population by 87%.[84] In addition, it significantly reduced the number of western harvest mice and additional species found poisoned (in insignificant numbers) were the thirteen-lined gound squirrel and the Mourning Dove. Spillage of small amounts of bait as the machine is lifted out of the ground is thought to present some localized hazard to seed-eating birds. No evidence of secondary poisoning was found, although 300 seeds were found in the pouch of one gopher.

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[83] Alberta Vet Med Assoc., 1976.

[84] Hegdal and Gatz, 1976.

Biociding of Lakes

Two studies reviewed describe the non-target species effects of rotenone, which is used by the Division as described in Section IV.

Effects of rotenone treatment of the Green River in Wyoming in October included:

--drastic reduction in adult beetles, snails, stonefly nymphs and other aquatic invertebrates;

--gradual reappearance of invertebrates within a month in the upstream 30-mile portion of the treated area;

--no reappearance of invertebrates in the downstream portion until spring;

--abnormal species composition two years after treatment.[85]

A study of the effects of fall application of 0.75 ppm derris root powder (5% rotenone) in Patricia Lake, Jasper National Park, showed:

--a "catastrophic" decline of crustacean zooplankton;

--no reduction of phytoplankton;

--reappearance of most zooplankton by ten months.

Although it was three years before species diversity and abundance returned to pre-treatment levels, the author concluded that a single-dose treatment has negligible adverse side effects.[86]

[85] Binns, 1967.

[86] Anderson, 1970.

ALTERNATIVE METHODS OF PEST CONTROL

The palliative nature of pesticides is often overlooked. If a pest can be permanently suppressed, the total cost, although sometimes greater in the developmental stage, will be less than that of conventional pesticides in the long run. Private industry has expended enormous time and money on chemical R & D and has thus far felt no motivation to develop alternatives to chemicals. Thus public agencies have undertaken the effort to date and will probably have to continue to do so in the immediate future at least. The total expenditure on this effort per year is small in comparison to that for development of chemical pesticides.

Alternative methods of pest control include the use of a) cultural and preventive measures; b) pest predators, parasites and pathogens, both introduced and indigenous; c) insect hormones and related chemicals; d) inbred crop resistance and e) genetically altered pest individuals. This report will not attempt to discuss the factors involved in each of these, but a few examples will be cited.

Cultural and preventive measures

The eggs of some insects (e.g. the red turnip beetle, a pest of rapeseed) can be destroyed by fall or spring plowing. Flea beetle control may be achieved by means of unswathed strips around infested fields: the beetles, which will then concentrate in the strips, can be sprayed with a minimal amount of insecticide. Summer fallowing of infested fields and trap strips may also control grasshoppers.[1]

For weed - and soil erosion - control in irrigation ditches, the seeding of certain grasses is being tested in Saskatchewan. Sheep fescue, streambank wheatgrass and Russian wild ryegrass look promising in this regard.[2]

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[1] Alberta Agriculture, "Agri-News".

According to a recent study,[3] reduction of winter coyote populations in agricultural regions of the province may be achieved by removal of livestock carrion; this major food source apparently governs density and distribution of coyotes in these areas to a great degree in winter. Removal of carrion did not result in increased predation on livestock.

Predators, parasites and pathogens

These agents include protozoa, fungi, bacteria, insects and viruses. In Canada, the following weeds now have insect predators under study or released successfully: nodding thistle, diffuse knapweed, spotted knapweed, Russian knapweed, Canada thistle, bull thistle, leafy spurge, St. John's-wort, toad-flax ragwort, bladder campion, perennial sow-thistle, and annual sow-thistle.[4]

The bacterium Bacillus thuringiensis is presently used against the cotton bollworm in the U.S. and the spruce budworm in Quebec. Recently, the first virus to be used as a pesticide was registered in the U.S.

A dipteran parasite of the larch sawfly has been released in the prairie provinces and is apparently effective. Parasites of the bertha armyworm and forest tent caterpillar are being studied in Alberta.

The cinereus shrew, introduced into Newfoundland to assist in control of the larch sawfly, has had a significant impact on the pest by preying on its cocoons.[5]

Roughly one-half of the insect pest species in the U.S. are exotics, having been introduced without their natural enemies. The prognosis for their biological control via importation of their natural enemies is good, provided that sufficient expenditure of effort is made in screening potential predators and parasites. For indigenous insect pest species, natural predators and parasites can sometimes be encouraged by plantings, re-introduction, and cessation of broad-spectrum insecticide application.

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[2] Ag. Pest Soc., newsletter, July 1975.
[3] Todd and Keith, 1976.
[4] Ag. Canada, "Canadex", no. 641.
[5] Howard, 1974.

C. Pheromones and insect hormones. Sex pheromones (attractants) and hormones which disrupt normal insect development are being developed by industry and government. The sex pheromones are now thought to be taken from food plants and stored by female insects. These, in combination with an insecticide, have been used successfully in the form of small lures to eliminate an oriental fruit fly population. They are highly species- specific and effective at extremely low concentrations. However, while they may prove useful for orchards, they are not expected to be useful in field crops, since the number of lures required would be large.[6]

A few of the scents suspected of being involved in communication between rodents have been chemically defined and are being examined for use in pest control (e.g. the house mouse preputial gland pheromone, the ventral gland pheromone in male Mongolian gerbils).[7]

Hormones that cause sterility in adults or death upon hatching (juvenile hormones) look promising for control of diptera. Analogs of naturally occurring juvenile hormones are now registered for mosquito control in Canada and are being tested for use in Alberta by Environment. Hornfly and housefly control by these means is being investigated by Alberta Agriculture. Juvenile hormones and their analogs are short-lived, possess low toxicity for mammals and are less toxic to fish than many pesticides.[8] Use of the minimal effective dosage for target organisms may allow for selective killing of target species only.[9]

[6] H. Philip, pers. comm.

[7] Christiansen, 1976.

[8] Hudson, 1973.

[9] H. Philip, pers. comm.

D. Crop resistance. Some grain and legume crop varieties have been bred for resistance to fungal and other diseases. However, the possibility of selection for adaptation in the pest populations, and hence reinfestation of the new varieties, is always present.

E. Genetic alternation of pest individuals. Mutagenic chemical and X-irradiation can be used to produce damage to the sperm cells in male insects; depending on the type of damage, this will result in death of offspring or inheritance of sterility in some of the male offspring. The former method requires inundation of the natural population with a great number of altered males, whereas the latter results in gradual transmission of sterility over successive generations. Both require that the natural populations be at a low ebb. The former technique is employed to keep the screw-worm fly from spreading into the U.S. from Mexico; the latter has been found to diminish natural populations during field trials with mosquitoes.[10] Other heritable, non-sex-linked defects, such as temperature sensitivity, may also be useful.

Integrated Pest Control

In some cases weed and insect control measures no longer aim at elimination of the pest organism. Data of the type presently being acquired by ADA, CDA and others allows the farmer to calculate his loss of crop per density of weed or insect pest, and from this calculate whether spraying is economical. Furthermore, information as to when to spray, based on regional or local assessment of the insect population density and biology, is being disseminated by agriculturalists and can help to minimize pesticide application.

Minimization of pesticide use may also be achieved through combinations of the above techniques, such as pheromone plus insecticide, or insecticide

[10] Laven et al., 1972.

followed by release of genetically altered individuals. In general, integrated approaches require much more knowledge of the biology and behavior of the pest organism than does application of conventional pesticides; and in most cases, this information is still lacking.

RECOMMENDATIONS

1. Role of the Division

A. In this age of chemical modification of the environment, greater effort toward preservation and enhancement of environmental quality is needed. It is strongly urged that the Fish and Wildlife Division take on a much more active part than it has in the past in the area of ecotoxicology.

B. For this purpose, it is recommended that a full-time staff position be designated responsible for the direction of all monitoring, research and joint programs dealing with pesticide and other toxic chemical research involving the Division and for representing the Division on all relevant committees. This position should be filled by a person knowledgeable in toxic chemicals research, especially in the methodology of such research.

C. It is further recommended that channels of communication and information regarding pesticides and other toxic chemicals be made available to all regional biologists, wildlife officers and any other staff members in a position to investigate ecological effects of these chemicals.

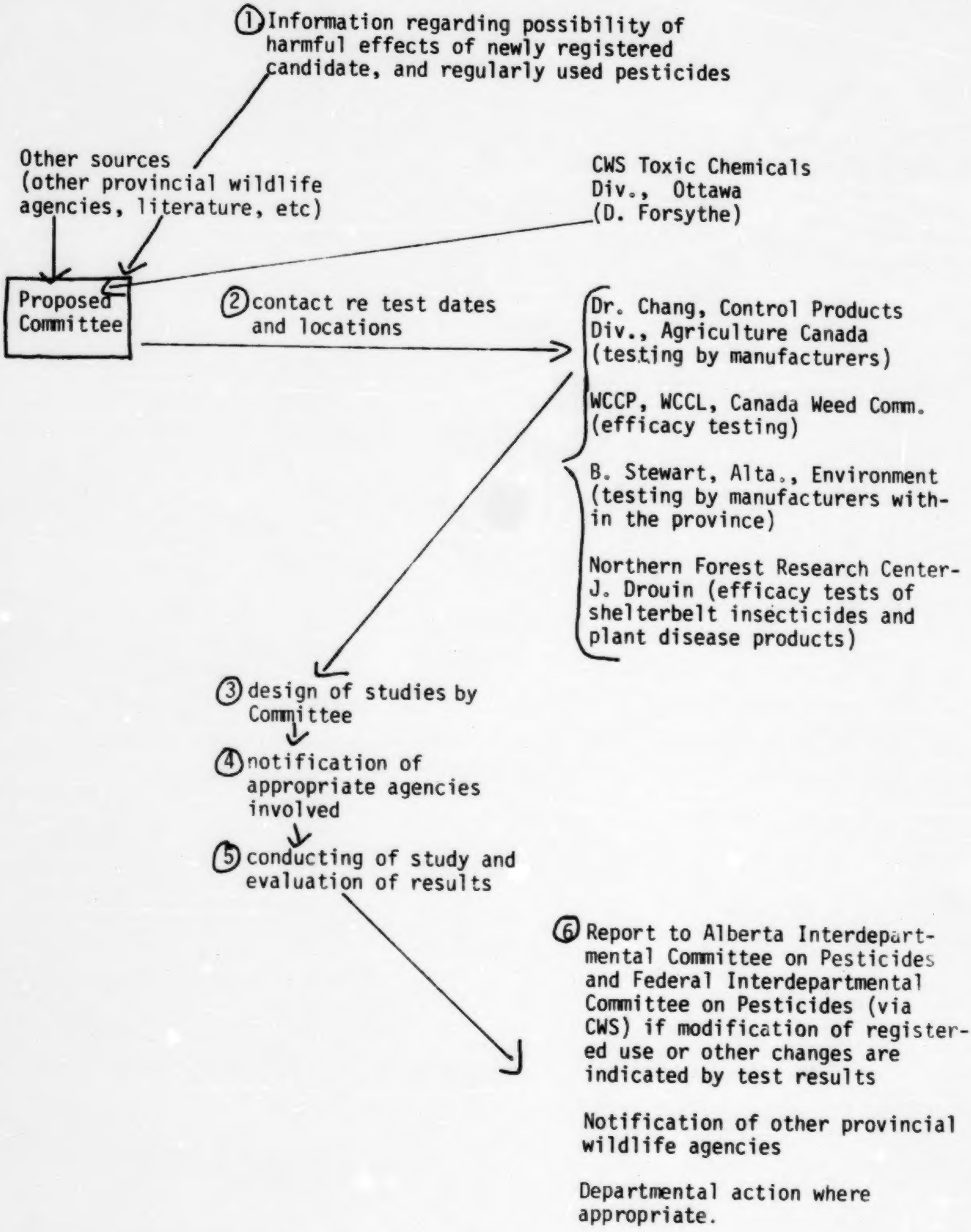
2. Organization of Research Programs

A. Fish and Wildlife Division should establish a formal or informal committee to direct research on the ecological effects of pesticides. This committee should include Alberta Environment, CWS Cooperative Studies (Toxic Chemicals Subdivision, Edmonton) and perhaps representatives from the Universities of Alberta and Calgary, the Freshwater Institute and other institutions.

B. Some of the research programs developed by the above committees should be conducted in conjunction with other agencies. The following have expressed a willingness to cooperate with the Division in this regard: Alberta Agriculture (Crop Protection and Pest Control Branch, Weed Control Branch); Alberta Environment (Pesticide Chemicals Branch); Northern Forest Research

Center; Inland Waters Directorate (Calgary); CWS Cooperative Studies (Edmonton) CWS Toxic Chemicals Division (Ottawa); and two Canadian chemical companies (Dow Chemical and Canadian Hoechst Ltd). It should also be noted that the Research Coordinator for Environmental Quality of Agriculture Canada called for the development of joint programs with environmentalists at the 1973 meeting of the C.C.P.U.A. Western Forum.

C. The process by which joint studies could be untaken is envisaged as follows:



① Information regarding possibility of harmful effects of newly registered candidate, and regularly used pesticides

Other sources (other provincial wildlife agencies, literature, etc)

CWS Toxic Chemicals Div., Ottawa (D. Forsythe)

Proposed Committee

② contact re test dates and locations

Dr. Chang, Control Products Div., Agriculture Canada (testing by manufacturers)

WCCP, WCCL, Canada Weed Comm. (efficacy testing)

B. Stewart, Alta., Environment (testing by manufacturers within the province)

Northern Forest Research Center-J. Drouin (efficacy tests of shelterbelt insecticides and plant disease products)

③ design of studies by Committee

④ notification of appropriate agencies involved

⑤ conducting of study and evaluation of results

⑥ Report to Alberta Interdepartmental Committee on Pesticides and Federal Interdepartmental Committee on Pesticides (via CWS) if modification of registered use or other changes are indicated by test results

Notification of other provincial wildlife agencies

Departmental action where appropriate.

3. Funding of Research

It is recommended that some of the required ecological research identified in this report be supported by the Department of Recreation, Parks and Wildlife Research Trust Fund.

Funding for research might also be obtained from the Provincial Environment and Agriculture Trust Funds and from chemical companies involved in manufacture of the products under study; the latter have provided limited support staff for studies conducted by Alberta Environment.

4. Conducting of Research

Many of the studies reviewed for this report were inconclusive due to poor experimental design or inadequate data generation. It is recommended that all tests be designed to yield statistically significant data; where time or manpower is not sufficient for adequate data collection, the study should be contracted out to university or consultants.

5. Methodology of proposed studies

Types of studies

The following types of studies could be undertaken. More detailed methodology for each of these is contained in EPA's guidelines for pesticide testing (Federal Register, Vol. 40, No. 123, June 25, 1975).

A. Field Studies

i. Penned bird study. Using registered formulations and rates of application, penned birds can be exposed to pesticides while being fed a pesticide-treated or untreated food supply. Young or adult birds can be used. A modification of this test involves spraying only the pens and placing the birds in them afterwards. Birds should be maintained at least three weeks after exposure to the pesticide, after which a pesticide residue determination and gross pathological examination should be conducted. If reproductive effects are included in the test, the duration of the test would be greater. Eggs could be collected and artificially incubated. This type of study

ii. Breeding bird census. Pre-and post-spray areal censuses could be conducted simultaneously with a control area census to determine changes in species numbers due to pesticide. Nests should be marked and checked. Either straight-line transects or plots can be censused.

iii. Arthropod numbers. A standard entomological procedure for pre-and post-spray determination of numbers can be followed, with emphasis on those species important to wildlife. Soil flora and fauna could also be assayed.

iv. Small mammal census. For determination of population density changes incurred by pesticide application, live-trapping recapture studies should employ replicate treatment grids and control grids on five consecutive trap-nights both before and after spraying.

v. Caged fish studies. Due to the mobility and non-random distribution of fish, caged studies or a combination of caged and sampling studies (such as in the Blackfly Control Program studies) may be desirable. Monitoring of residues in the fish, water, and bedload and water quality parameters such as pH and conductivity should be included. Mortality, pathological and behavioral changes in fish should be examined. The study could also be designed to include investigation of effects of the pesticide on fish reproduction.

vi. Field monitoring of aquatic residues. A simple and reputedly sensitive means of toxicity assay, which can be used when analytical facilities are not available or pesticides are short-lived, involves a total population density monitoring of crustacea and aquatic invertebrates, both of which groups are highly sensitive to the presence of pesticides. Numbers are compared to baseline data (see Bull. Env. Toxic. 14 for details).

vii. General pesticide residue sampling. Pre-and post-spray samples should be taken of a) 1 or more species of common resident (omnivorous or granivorous) bird, b) 1 or more species of common resident (omnivorous or granivorous) mammal, c) abundant arthropod species, d) vegetation, e) vegetative litter, f) soil to a depth of approximately 2½ cm. and g) water.

B. Laboratory studies

i. Aquatic studies Bioassays of the effect of a pesticide on local aquatic invertebrate species could be conducted in aquaria. The percent hatchability, number of pupae, number of adults, reproduction and egg deposition and development of larvae can be compared to controls for two generations. Fish life cycle bioassays could also be conducted. This type of study could be handled by the Water Quality Control Lab, Alberta Environment, which will have bioassay facilities in Vegreville.

ii. Model aquatic ecosystem. A simple, compartmentalized model for the study of the fate of a pesticide in an aquatic system can be conducted using three trophic levels: a microorganism (e.g. yeast); a filter-feeder (e.g. *Daphnia magna*) and a fish species. For each trophic level, this system can yield information on both the direct uptake of pesticide from the water and the transfer of accumulated pesticide from a lower to a higher trophic level.

6. Specific Studies Required

Below are the information gaps identified during this study. More will undoubtedly surface upon further investigation by the proposed committee.

A. One of the primary ecological research needs is data regarding actual ground exposure rates that can be expected from various aerial application rates, pressures, and pesticide formulations. It is recommended that the proposed committee undertake a cooperative study with Dr. R. Laurin, Agricultural Chemicals Instructor at Lakeland College, who has the facilities, interest and expertise to carry out such studies.

B. It is recommended that the proposed Committee address itself to the question of whether the environmental information required for registration of pest control products is in general adequate; also that it consider whether better guidelines could be given to manufacturers with regard to such data; and also whether certain field studies of effects on non-target organisms should be required in support of first or second renewal applications for pest control products (as recommended by the E.C.A.[11]).

C. Some of the concerns regarding certain chemicals identified in Section VI are listed below according to a highly speculative order of priority based on amount of use received in the province and magnitude of possible effect.

i. Diesel fuel oil - study of allowable concentration with regard to avian embryo toxicity;

ii. Lindane - More information on accumulation in seed-eating species;

iii. Malathion - study dealing with reputed teratogenicity to chick embryos and other pathological changes at normal application rates; secondary toxicity studies;

iv. Organophosphates in general - Further information as to the nature of chronic, cumulative effects;

v. Carbofuran - Feeding studies to assess potential for secondary poisoning to predators of insects and earthworms; effect on soil microorganisms; further check on safety of the spray formulation and 5% granular formulation for ducks;

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[11] E.C.A., 1976.

vi. Picloram and other "soil sterilants" - Effects in wetland ecosystems;

vii. Abate - Possibility of secondary toxicity to insectivorous avian fauna;

viii. Dimethoate - cumulative secondary toxicity to insectivorous birds (including young);

ix. 2,4-D - Further study (by disinterested parties) to resolve contradictory results regarding effects on avian embryos; research on possible significance to wild herbivores of reported increase in palatability of poisonous plants for livestock;

x. Azinphos-methyl, demeton, diazinon - field study on secondary toxicity to birds, insectivorous birds and mammals;

xi. Paraquat - Possibility of pathological effects on small mammals and birds when sprayed on shelterbelts or as part of a soil sterilant mixture;

xii. Endosulfan - Information regarding presence and effects of residues of endosulfan and its metabolities (especially endosulfan sulfate) in aquatic systems;

xiii. 2,4,5-T, Silvex - Bioaccumulation in aquatic ecosystems;

xiv. Simazine - Possibility of biomagnification and/or secondary poisoning of waterfowl, fish and semi-aquatic mammals;

xv. Diquat: paraquat mixture - Laboratory-type bioassay of toxicity at recommended application rates to important aquatic macroinvertebrates;

xvi. Hoe-Grass - subacute inhalation toxicity under actual rates of exprosure; uptake by aquatic plants and invertebrates important to fish.

xvii. Fenthion (Baytex) - if use in province increases - information on effects on avian fauna (especially waterfowl and shorebirds).

xviii. Mercury - containing turf fungicides (Calomel) - extent of use.

7. Alternative Methods of Pest Control

A. Alberta Agriculture is commended for its educational efforts dealing with the biology of weed, insect and vertebrate predator pests (life cycles, habitat, etc.). It is recommended that, when a choice between effective cultural and chemical control measures exists, the cultural methods be fully described and that both the economic and ecological pro's and con's of each method be presented.

B. With almost all R & D efforts on alternative methods of pest control supported by government funds, it is recommended that Fish and Wildlife and the proposed Committee sponsor research in the area of biological pest control. According to the Environmental Conservation Authority, funding of this type of research at the university level has diminished to the point of jeopardy for those involved.[12]

8. Cooperation with the Pesticide Chemicals Branch

A. The Pesticide Chemicals Branch of Alberta Environment is to be commended for its support of research dealing with effects of pesticides usage, its educational programs for pesticide dealers and applicators, and its stand regarding chemicals which have been demonstrated to be detrimental to the environment. The Branch has been firm in restricting the use of such chemicals; hence the necessarily speculative nature of that section of the present report dealing with the effects of currently used pesticides.

B. It is recommended, as requested by the Pesticide Chemicals Branch, that the Fish and Wildlife Division contribute to the teaching of the pesticide applicators' course given annually at Olds by the Branch.

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[12] E.C.A., 1976

C. Enforcement capability under the Agricultural Chemicals Act is poor at best, with municipalities charged with the responsibility for investigating complaints and enforcement. Although there are approximately 340 municipal inspectors having this duty in the province, most of them also serve as weed inspectors, agricultural fieldmen, and other municipal officers, and often have little or no education in toxicology, pesticides, or wildlife biology. The only successful prosecutions under the Act have been those which were not contested.

D. It is recommended that the Division support Environment's request for full-time enforcement personnel, each responsible for an area within the province. It is also recommended the Fish and Wildlife enforcement officers be trained and used for enforcement of this Act where their services would be deemed useful by Environment.

9. Pesticide disposal.

At present, left-over pesticides and their containers are commonly discarded in landfill sites, where any remaining chemical may be subject to evaporation, sublimation and transport by wind, and, occasionally, open burning and entry into temporary bodies of water. Some pesticides require combustion at 1000^0 C. for a minimum of two seconds for adequate destruction. An Agriculture Canada publication for pesticide users states that the manufacturer should be contacted for disposal instructions. In the case of a small amount of left-over chemical, this is an unrealistic expectation. An interdepartmental committee on hazardous waste, including EPS and Alberta Environment, is looking into alternatives to present transport and disposal methods.

B. It is recommended that the Division support the establishment of better disposal facilities for pesticides. Also it is recommended that the Division, in conjuction with Agriculture, undertake a program to inform agricultural and other landowners of the environmental dangers from burning, above-ground disposal, and improper burial of left-over pesticides and containers.

10. Application to open bodies of water.

A. The Agricultural Chemicals Act excludes from its provisions "lakes or sloughs that are completely surrounded by private lands and where there is no drainage of water from the lakes or sloughs through the private lands." This exclusion is not consistent with the Public Lands Act (Section 4) in which the land under such water is declared to be public land.

B. It is recommended that this Act be amended to include such water bodies in its regulations. It is recognized that small sloughs, although often ecologically important, cannot be avoided during aerial application of pesticides. Specification of a minimal size of water body, for example ten acres, beyond which application is prohibited, might therefore be necessary.

C. It is further recommended that Fish and Wildlife undertake a program to inform landowners of the ecological effects of applying pesticides to bodies of water.

11. Use of herbicides on Crown land.

A. While initial clearing of trees on Crown land by Forestry and Lands is regarded as beneficial to wildlife in many cases, the Division opposes the following practices:

i) the use of diesel oil carriers with herbicides during spring and early summer;

ii) the repeated application of herbicides for the establishment and maintenance of monocultures on Crown land;

iii) the use of herbicides for initial clearing of trees in cases where mechanical clearing is possible.

12. Roadside herbiciding.

Because of its importance for both aesthetic and wildlife functions, it is recommended that vegetation along minor roads be treated in the following manner:

(a) portion of road allowance between road and ditch - it is recognized that snow removal requires the pushing of snow from the roadside into the ditch and therefore all non-flexible shrubs and trees must be removed from this portion (this would exclude rose, raspberrry, and such flexible, small shrubs). If noxious weeds are present and pose a threat to adjacent farmland, this portion should be seeded to grass or grass-legumes; this will require backsloping if sufficient topsoil is not present.

(b) portion of road allowance between ditch and fenceline - Selective removal of trees which pose a threat to powerlines is recommended, with the shrub and low tree community left intact. If backsloping is necessary in (a), a shrub community should be allowed to regrow in the ditch-fenceline portion if feasible.

(c) exception to (a) and (b) - Roadside stretches having vegetation that tends to cause snowdrifting across the road will require removal of dense shrubs and thinning of trees (see discussion under Effects section). It is hoped that either local crews or (as recommended by the E.C.A.) an organization such as the Neegan Society undertake mechanical clearing.

13. Use of pesticides by the Division.

For the present, until such time as some of the more advanced genetic tests available are used in pesticide testing, it is recommended that Fish and Wildlife avoid the use of suspected mutagens (listed in Appendix A) for habitat improvement programs. Furthermore, it is recommended that pesticides having potential detrimental environmental effects as described in this report not be employed by the Division with the exception of cases in which well-designed studies of these effects can be incorporated into the program.

14. Interprovincial communication.

Fish and Wildlife Division should inform other provinces of the results of these studies and foster an exchange of interprovincial communication regarding pesticide problems on an informal level. The Canadian Wildlife Administration Magazine might be a useful vehicle for this communication.

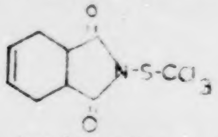
Appendix A.

Pesticides Used in Alberta Having Probable Mutagenic Properties

Appendix A.1. Submission to the E.C.A. Public Hearings by the Environmental Mutagen Society

Mutagenic Activity of Captan

Captan is a fungicide which is commonly used in Alberta. It has the following structural formula:



and goes by many trade names. It is used world wide, for example, as a spray on fruits, vegetables, flowers, and vineyards, and as a general fungicide protectant in paints, plastics, leather and fabrics. The toxic effect of captan seems to be based principally on its reactivity with cellular thiols, and, depending on the nature of the reacting thiol, captan can give rise to several end products. Recently it has been found that the mutagenic activity of captan is expressed in two different ways, one of which is a volatile breakdown product.

The results of numerous tests for the mutagenic activity of captan are shown in the table. It can be seen that captan induces a wide variety of mutagenic responses in numerous organisms. Captan is particularly active as a mutagen on microbial and cellular systems, and does not appear to be especially active on whole organisms.

Nevertheless, a positive test in the host-mediated assay indicates that captan or its mutagenic breakdown products can be carried in the bloodstream of mammals to sensitive target cells, although there is some evidence (Arlett and Harcourt, unpublished data) that captan can be at least partially inactivated by blood serum. Two other observations indicate that caution must be exercised: First, captan did not induce dominant lethal damage in the mouse, but it did increase the frequency of early foetal deaths; second, captan has been found to induce teratomas in chick embryos.

Moreover , Bridges and his colleagues have stated "The mutagenic properties of captan are in essence those of one or more alkylating agents. We suggest that serious consideration be given to the possibility of a carcinogenic hazard from inhaled captan dust particles, which are almost insoluble in water and which would be expected to persist for some time, slowly releasing mutagenic agents into the surrounding cells."

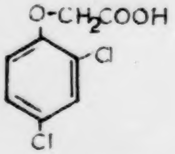
Recommendation: Captan should not be used if other nonmutagenic fungicides are available. If it must be used, great care should be taken to avoid inhaling the compound. Captan has not yet been tested in the liver microsomal test system for its carcinogenic activity. Such a test also would indicate whether the liver breaks down captan into inactive end products. This test should be carried out as soon as possible in order to more properly evaluate the carcinogenic effect of captan on humans. Prima facie, captan would appear to be a strong candidate for inducing lung cancer.

Captan: Types of genetic and cytological damage detected by currently employed mutagen screening systems.

Screening system		Dominant lethality	Translocations	Chromosome breaks	Inhibition of mitosis	Induced recombination	Gene mutations	
Category	Organism						Forward	Reverse
Bacterial	*Salmonella typhimurium*							+
	Escherichia coli						+	+
	Serratia marcescens							+
Fungal	*Neurospora crassa*						+	–
	Saccharomyces cerevisiae					+		
Plant	*Zea mays*	–						
Insect	*Drosophila melanogaster*	–	–				–	
Mammalian cell culture	Rat kangaroo kidney cells			+	+			
	Human embryo cells			+	+			
Host-mediated assay	*S. typhimurium* in the mouse							+
Intact mammal	Mouse	–						

Mutagenic Activity of 2,4-D

2,4-D (2,4-dichlorophenoxyacetic acid) is a general herbicide which is particularly effective on broad-leaved plants. It has the following structural formula:



The toxic effect of 2,4-D seems to be based principally on inhibition of the cellular control for plant cell elongation. This inhibition then can be so drastic that other cell control mechanisms become affected. It seems likely that the cytological effects on chromosomes seen in plants come about by this indirect effect rather than by a direct effect on the genetic material, although some well-qualified investigators argue otherwise. Indirect effects may be the basis for the increased frequencies of induced recombination in yeast cells as well, but the interesting genetic effect of 2,4-D on yeast is certainly a signal that more screening is required.

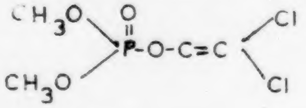
Recommendation: Although sufficient mutational testing and tests for carcinogenicity of 2,4-D are still lacking for adequate evaluation, the best educated guess that one can make from the extant data is that 2,4-D probably can be adjudged as "safe" with respect to its being a mutagenic hazard to man.

2,4-D: Types of genetic and cytological damage detected by currently employed mutagen screening procedures

Screening system		Dominant lethality	Chromosome breaks	Induced recombination	Gene mutations	
Category	Organism				Forward	Reversed
Bacterial	*Salmonella typhimurium*					−
	Bacteriophage				−	−
Fungal	*Saccharomyces cerevisiae*			+		
Plants	*Tradescantia* sp.		+			
	Allium cepa		+			
	Triticum aestivum		+			
	Triticum dicoccum		+			
	Hordeum vulgare		+		+	
	Secale cereale		+			
	Centaura jacea		+			
	Cirsium vulgare		+			
	Chrysanthemum leucanthemum		+			
	Plantago major		+			
	Erigeron canadensis		+			
Mammalian cell culture	Rat bone marrow		+			
Host-mediated assay	*S. typhimurium* in the rat			−		−
Intact mammal	Mouse	−				

Mutagenic Activity of Dichlorvos

Dichlorvos (2, 2-dichlorovinyl dimethyl phosphate) is an insecticide which is commonly used everywhere in North America. It has the following structural formula:



It has many trade names, being an active ingredient in Vapona. Dichlorvos has alkylating properties.

The results of a number of tests are shown in the table. It can be seen that Dichlorvos is particularly active mutagenically in bacterial test systems, and it breaks chromosomes in the cells of higher plants as well.

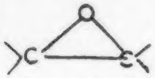
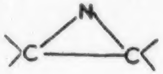
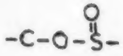
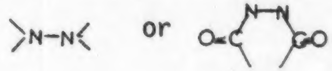
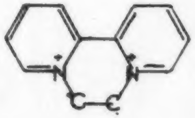
The dominant lethal test in the mouse is an insensitive test, but the fact that Dichlorvos is negative in the host-mediated assay indicates that the compound may be rapidly inactivated in intact mammals. Very small quantities of Dichlorvos were tested in the host-mediated assay (0.2 mg/mouse); larger amounts were toxic to the animal.

Recommendation: Clearly, Dichlorvos should be more rigorously assayed for mutagenicity and carcinogenicity in higher mammals before it is declared a "safe" pesticide. Because inhalation could cause the compound to come into contact with lung cells, it should not be used under conditions where it can be inhaled until negative tests for carcinogenicity are available.

Dichlorvos: Types of genetic damage detected by currently employed mutagen screening systems.

Screening system		Dominant lethality	Chromosome breaks	Induced recombination	Gene mutations	
Category	Organism				Forward	Reverse
Bacterial	*Salmonella typhimurium*					+
	Escherichia coli				+	+
	Pseudomonas aeruginosa					+
Fungal	*Neurospora crassa*					−
	Saccharomyces cerevisiae			+		
Plant	*Allium cepa*		+			
Host-mediated assay	*S. typhimurium* in the mouse					−
	Serratia marcescens in the mouse					−
Intact mammal	Mouse	−				

Appendix A.2. Mutagenic Chemical Properties of Some Pesticides*

Chemical structure	Compounds	Examples used in Alberta
A. Compounds having structures that are known to affect DNA. Any compound having such a structure should be proven harmless before humans are exposed to it.		
a) Alkylating agents. These induce point mutations (transitions) and large chromosomal alterations:		
	- Epoxides (ethylene oxide; endrin; dieldrin)	- heptachlor epoxide (from heptachlor and also from chlordane)
	- Ethyleneimines (aziridines, such as TEPA)	
 $-C-O-\overset{O}{\overset{\|}{S}}-$	- Sulphates (Aramite)	
	- Certain bromides and chlorides (bromomethane; bromopropane; ethylene dibromide)	- ethylene dibromide
b) Radical producing agents. These induce large chromosome alterations but not point mutations:		
	- Hydrazines or hydrazides (maleic hydrazide, known to break chromosomes)	- maleic hydrazide
	- Bipyridylium quarternary salt (Diquat, paraquat). Known to produce radicals and to kill plants in the presence of oxygen (presumably via peroxide radicals affecting DNA)	- diquat, paraquat, chloramquat, difenzoquat (Avenge)
c) Base analogs.		
	- 5-fluorouracil; fluoroorotic acid. Both inhibit DNA synthesis.	

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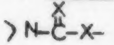
* Adapted from Epstein, S. and M. Legator, Mutagenicity of Pesticides, M.I.T. Press, 1971. (Third column added by author of this report).

B. Compounds suspected to affect DNA or to be activated enzymatically. These pesticides must be tested for their mutagenicity in higher organisms.

a) Unsaturated rings with -OH or SH groups. Some phenols and cresols are known to produce chromosome breaks, perhaps due to radical formation in presence of oxidizing groups.

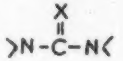
Chemical structure	Compounds	Examples Used in Alberta
	- Ioxynil; niacide; orthophenylphenol; PCP	- Ioxynil

b) Carbamates and Thiocarbamates.

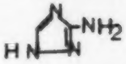
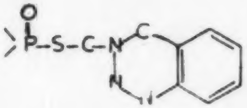
 $>N-\overset{X}{\overset{\parallel}{C}}-X-$ X=O or S	- Barban; Bux Ten; carbaryl; carbofuran; dimetilan; metham; Mobam; propachlor; 2,3,6-TBA; thiram; vapam; ziram .	- Barban; carbaryl; carbofuran, dimetalin; 2,3,6-TBA; propachlor; metiram; thiram

Ethylcarbamate and several other carbamates are well known to produce chromosome breaks, cancer and teratogenic effects. They do not affect DNA directly, but their enzymatic products, such as N-hydroxycarbamates and other intermediates, which in turn produce radicals, cause inactivating DNA alterations; thus, chromosome breaks and large chromosome alterations, but not point mutations, can be induced. Whether or not a particular carbamate is mutagenic depends therefore on the presence of N-hydroxylating enzymes in the cells.

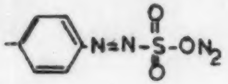
c) Ureas

 $>N-\overset{X}{\overset{\parallel}{C}}-N<$ X=O or S	- chloroxuron; diuron; fenuron; linuron; norea. These compounds also produce inactivating DNA alterations if they are activated (N-hydroxylation)	- Diuron; linuron; fenuron

d) Compounds having 2 or 3 nitrogens connected.

	- Triazoles (amitrole)	- amitrole
	- Benzotriazines (azinphosethyl; azinphosmethyl)	- azinphosmethyl

Appendix A.2. Ct'd

Chemical structure	Compound	Examples Used in Alberta
	- Diazo compounds (Dexon)	

e) Mercurials. Some mercurials are known mutagens.

- Elcide; Emmi; Panogen; Ceresan M; Semesan Bel.

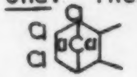
f) Organophosphates. These compounds are phosphate triesters which are labile to hydrolysis. Although not tested, som e of them may react with DNA by transalkylation.

	- Parathion; methylparathion; malathion; demeton; disulfotone; dimethoate; phorate; phosphamidon; Ruelene	- numerous examples

g) Other reactive compounds.

	- Acrolein; allyl alcohol; acrylonitrile (known to react with 4-uridine, inosine, t-RNA)	- acrolein

h) Chlorinated cyclodienes having an unsaturated group in a ring attached to the chlorinated one. These compounds are known to be converted into epoxides that are found in body fat.

	- Aldrin; Isodrin; heptachlor	- as in A.

i) Base analogs. Some of these compounds may possibly inhibit DNA synthesis.

-Benlate; isocil; lenacil; terbacil

j) Potential intercalating compounds. Some of these may act similarly to acridine and intercalate between DNA bases.

- Anthraquinone; phenothiazine

Appendix B.

Proposed Classification of Pesticides in Alberta

Schedule A (Permit from Alberta Environment required; use by licensed applicators only)

Compound	Concentration
parathion-ethyl	all
parathion-methyl	all
sodium fluoroacetate	all
TEPP	all
thallium & its salts	all

Schedule B (Permit from either Alberta Environment or municipality required; for use by licensed applicators, farmers and grain handlers only)

aluminum phosphide	all
DDT	all
strychnine	>2%
strychnine salts	>2%
zinc phosphide	>5%
carbon disulphide	all
chloropicrin	>15%
ethylene dibromide	>25%
ethylene dichloride	>25%
methyl bromide	all
hydrogen cyanide	all
picloram (from inorganic salts)	all
picloram (from amines)	all
paraquat	>2.5%

Schedule C (No permit required; available to licensed applicators and farmers, who must sign for the chemical)

acrolein	all
acrylonitrile	all
aldicarb	all
aldrin	all
aminocarb	>30%
antimycin	all
antimony potassium tartrate	all
benzene hexachloride (-BHC, -HCH)	>75%
carbofuran	>11%
calcium arsenite	>10%
chlorofenvinphos	>10%
chlorophacinone	>5%
chloropicrin	≤15%
carbophenothion	>10%
cycloheximide	> 2%
demeton	all

Schedule C ct'd

Compound	Concentration
dieldrin	all
disulfoton	>10%
dimetox	all
dinoseb	>25%
DNOC	>30%
dinitrophenol	all
diphacinone	>1%
2,4-D butyl ester	all
dyfonate	>3%
ethylene dibromide	≤25%
ethylene dichloride	≤25%
endrin	all
endosulfan	>28%
fentin hydroxide	>46%
fensulfothion	>2%
fenoprop butyl esters	all
formetanate hydrochloride	>20%
fumarin	>25%
glyodin	>6.8%
azinphosmethyl	>13%
gophacide	>3.7%
heptachlor	all
arsenic from lead arsenate	all
MCPA butyl esters	all
methidathion	>65%
mevinphos	>6%
methomyl	>17%
methamidophos	>19%
phosphamidon	>17%
phorate	>1%
sodium arsenite	all
sodium fluoride	> 75%
sulfotep	>7%
strychnine	≤2%
strychnine salts	≤2%
sulfaquinoxaline (Na salt)	>5%
toxaphene	all
trichloronate	>37.5%
2,4,5-T butyl esters	all
zinc phosphide	≤5%
thionazin	all
mexacarbate	>19%

Schedule D (No permit or signature required; large containers only available)

Compound	Concentration
allyl alcohol	all
acetic acid	all
alachlor	all
allidochlor	all
alphachloralose	all
arsenic from octyl and dodecyl ammonium methyl arsonates	>10%
aminocarb	≤30%
4-aminopyridine	all
ammonium sulphamate	>78%
ametryne	all
ancymidol	all
anthracene oil	all
anthracine oil	all
aramite	all
asulam	all
triazines from atrazine	all
auramine	all
Avenge	all
terbutal	all
azobenzene	all
aziprotryn	all
benfluralin	all
barban	all
2-aminoethyl salt of 2:5-dichloro-4-nitrosalicylanilide	all
metribuzin	all
propoxur	>19%
cyanazine	all
benazolin	all
gamme-BHC from benzene hexachloride (lindane)	≤75%
borax, anhydrous	all
borax pentahydrate	all
disodium ocatborate tetrahydrate	all
boracic acid	all
dienochlor	all
binapacryl	all
bromophos	all

Schedule D ct'd

Compound	Concentration
bromoxynil from bromoxynil esters	all
Bacillus thuringiensis Berliner	all
m-(1-methylbutyl) phenyl methylcarbamate	all
m-(1-ethyl propyl) phenyl methylcarbamate	all
bentazon	all
benoxylprop ethyl	all
carbaryl	>10%
cacodylic acid	all
carbofuran	≤11%
calcium arsenate	≤10%
chlorbromuron	all
chlorobenzilate	all
chlormequat	all
cadmium chloride	all
cadmium sebacate	all
cadmium from cadmium succinate	all
chlordimeform	all
chlordimeform hydrochloride	all
chlorfenvinphos	≤10%
chloramben from chloramben salts	all
chlordecone	>23%
chlorophacinone	≤ 5%
crotoxyphos	all
chlopropham	all
chlordane	>5%
chloroxuron	all
chloroneb	all
coumaphos	all
chloropicrin	≤4%
carbophenothion	≤10%
cresylic acid	>10%
creosote	>10%
carbon tetrachloride	all
copper from copper sulphate	all
cycloheximide	≤2%
daminozide	all
dazomet	all
dichlobenil	all
1,2-dibromo-3-chloropropane	all
disul	all
fenaminosulf	all
captafol	all

Schedule D cont'd

Compound	Concentration
diazinon	>60%
dicamba from dicamba salts	all
diallate	all
dimethoate	>64%
diphenamid	all
diquat	>3%
disulfoton	≤10%
dioxacarb	all
arsenic from disodium methyl arsonate	all
dinitramine	all
dinoseb	≤25%
DNOC	≤30%
dodemorph	all
diphenylamine	all
2,4-dichlorophenoxy butyric acid	all
diphacinone	≤1%
1-2 dichloropropane 1,3 dichloropropane	all
chlorpyrifos	all
diuron	all
dichlorvos	>11%
2,4-D	>74%
2,4-D from 2,4-D amines	>74%
2,4-D from 2,4-D salts (Inorganic)	>74%
2,4-D (N,N-dimethyloleyamine salt)	all
Dyfonate	≤3%
endothall	all
erbon	all
endosulfan	≤28%
ethephon	all
ethion	>19%
eucalyptus oil	>10%
fentin hydroxide	≤46%
fensulfothion	≤2%
fenithrothion	all
fenthion	>38%
2,3,6-trichlorophenyl acetic acid	all
formetanate hydrochloride	≤20%
formaldehyde	all
fumarin	≤25%
tetrachlorvinphos	all
glyodin	≤6.8%
azinphos-methyl	≤13%
gophacide	≤3.7%
N,N'-dimethyl-N' (5-trifluoromethyl -1,3,4-thiadiazolyl-(2)) - urea	all
hexachlorophene	>64%
hydrogen cyanamide	all
phosmet	>43%
ioxynil	all

Schedule D con't

Compound	Concentration
potassium chromate	all
3,5-dichloro-N-(1,1-dimethyl-2-propynyl) benzamide	all
leptophos	all
Lethane	>13%
fenozaflor	>57%
linuron	all
malachite green	all
MCPB from MCPB salts	all
mercuric chloride	all
methyl dodecyl benzyl trimethyl ammonium chloride	all
methyl dodecyl xylene bis trimethyl ammonium chloride	all
mecoprop (disomer) from mecoprop salts	>13%
methidation	<65%
mevinphos	<6%
2-Methoxoyethanol	all
methyl isothiocyanate	all
methomyl	<17%
mineral oil (herbicidal)	all
monolinuron	all
methamidophos	<19%
monuron	all
monuron trichloroacetate	all
chinomethionat	all
mercurous chloride	all
monosodium acid methane arsonate	all
metobromuron	all
metiram	all
naled	>86%
maptalam	all
nicotine	>10%
tertiary octyl mercaptan	all
oxydemton-methyl	>13%
propargite	all
cyprazine	all
paraquat	>3%
N-(p-bromophenyl)-N-methoxy urea	all
pentachlorophenol	>10%
paraformaldehyde	all
phosphamidon	<17%
phorate	<1%
phosalone	>24%
pindone	>10%
pirimicarb	>30%
nitralin	all
phenyl mercuric acetate	all
phenyl mercury oleate	all
phenmedipham	all
Protection Odour 547	all
propionic acid	all
propham	all

Schedule D cont'd

Compound	Concentration
propanil	all
prometryne	all
oxycarboxin	all
5-amino-4-chloro-2-phenyl-3 (2H) pyrid-azinone	all
quintozene	all
S-ethyl cyclohexylethyl thiocarbamate	all
ronnel	all
rosemary oil	>10%
rotenone	>26%
crufomate	all
sodium fluoride	<75%
sulfotep	≤7%
siduron	all
solan	all
solium metabonate octahydrate	all
sodium metaborate Tetrahydrate	>10%
sulfaquinoxaline from sodium salt	≤5%
socium tetrachlorophenate	all
streptomycin	all
sulfallate	all
butylate	all
di-n-butyl succinate	all
terbutryn	all
terbuthylazine	all
2,4,5-trichlorophenol	all
2-(thiocyanomethylthio) benzothiazole	all
tetrachlorophenol	all
tebuthiuron	all
tecnazene	all
terbacil	all
4-chlorophenyl 2,4,5-trichlorophenyl sulphide	all
chorothalonil	all
thyme oil	>10%
niclofen	all
thiophanate-methyl	all
trichloronate	≤37.5%
trichlorfon	>90%
triallate	all
triforine	all
2,4,5-T from 2,4,5-T amines	all
thiabendazole	all
S-propyl dipropyltio carbamate	all
carbothiin	all
warfarin	>65%
ziram	all
zinc phosphide	<0.5%
mexacarbate	≤19%

Schedule E (For domestic use; cannot be sold in food stores)

Compound	Concentration
temephos	all
d-trans-allethrin	all
allethrin	all
arsenic from octyl and dodecyl ammonium methyl arsonates	≤10%
amitrole	all
ammonium sulphamate	≤78%
atrazine	all
propoxur	≤19%
bromacil	all
bensulide	all
gamma - BHC from benzene hexchloride (Lindane)	≤7.5%
benomyl	all
bone oil	all
bis (tri-N-butyltin) oxice	all
benzene	all
carbaryl	≤10%
captan	all
chlordecone	≤23%
chlorthal	all
oil of citronella	>20%
chlordane	≤5%
coal tar acids	all
coal tar oils	all
cresylic acid	≤10%
creosote	≤10%
copper from tribasic copper sulphate	all
copper from copper naphthenate solution	all
cutrine	all
copper from copper oxychloride	all
dalapon	all
dicofol	all
dichlone	all
diazinon	≤60%
dichloran	all
dimethoate	≤64%
dinocap	all
diquat	≤3%
dodine	all
dichlorophen	all
N,N-diethyl-m-toluamide	>40%
dichlorvos	≤11%
2,4-D	≤74%
2,4-D from 2,4-D amines	≤74%
2,4-D from 2,4-D salts (Inorganic)	≤74%
dyrene	all
ethyl di-n-propylthiol carbamate	all
endosulfan	≤2.8%
ethion	≤19%
eucalyptus oil	≤10%
ferbam	all
ferrous sulphate	all
fenthion	≤38%
folpet	all

Schedule E cont'd

Compound	Concentration
hexachlorophene	<64%
phosmet	<43%
potassium cyanate	all
Lethane	<18%
fenozaflor	<57%
MCPA from MCPA amines	all
malathion	all
maneb	all
MCPA from MCPA salts	all
mancozeb	all
mecoprop (disomer) from mecoprop salts	<13%
methidathion	<6.5%
menazon	all
methoxychlor	all
n-octyl bicycloheptene dicarboximide	>10%
metaldehyde	all
mineral oil (insecticidal)	all
metam (sodium)	all
nicotine	<10%
orthodichlorobenzene	>16%
oxydemeton-methyl	<13%
Ovex	all
paraquat	<3%
pentachlorophenol	<10%
piperonyl cyclonene	all
paradichlorobenzene	all
1,1-dichloro-2,2-bis (p-ethyl phenyl) ethane	all
phosalone	<24%
pindone	<10%
pirimicarb	<30%
trichyclohexyltin hydroxide	all
polymerized butenes	all
2 methoxy-4,6-bix (iso-propylamino)-s-triazine	all
pyrethrins	>30%
resmethrin	>85%
rosemary oil	<10%
rotenone	<26%
red squill	all
sodium chlorate	all
sulfoxide (technical)	all
sodium fluoride	<7.5%
sodium fluosilicate	all
amorphous silica aerogel	all
sodium metaborate Tetrahydrate	<10%
simazine	all
sulfaquinoxaline from sodium salt	<.5%
sulphur	all
sulphide sulphur (lime sulphur)	all
tandex	all
2,4,5-TBA	all
tetradifon	all
isobornyl thiocyanoacetate	all
thiram	all

Schedule E cont'd

Compound	Concentration
thyme oil	≤10%
trichloronate	≤3.8%
trifluralin	all
trichlorfon	≤90%
warfarin	≤65%
zineb	all
zinc naphthenate	all
mexacarbate	≤1.9%

Schedule F (For domestic use; can be sold in any type of outlet)

Compound	Concentration
borax	all
butoxypolyproplene glycol	all
capsaicin	all
oil of citronella	≤20%
dimethyl phthalate	all
N,N-diethyl-m-toluamide	≤40%
dichlorvos	≤1.1%
2-ethyl-1,3-hexanediol	all
eucalyptus oil	≤1%
2:2-dimethyl-6-carbonbutoxy-2"3-dihydro-4-pyrone	all
oil of Lavender	all
di-n-propyl isocinchomeronate	all
2-hydroxy ethyl N-octyle sulfide	all
n-octyl bicycloheptane dicarboximide	≤10%
Methyl nonyl Ketone	all
mustard oil	all
tetramethrin	all
nicotine	≤1%
oil of lemongrass	all
orthodichlorobenzene	≤16%
piperonal bis (2-(2-butoxy ethoxy)ethyl) acetal	all
piperonyl butoxide (technical)	all
pyrethrins	≤30%
resmethrin	≤85%
rosemary oil	≤1%
rotenone	≤2.6%
silicon dioxide	all
insecticidal soaps	all
thyme oil	≤1%

Appendix C.

Pesticide Use: Membership and Terms of Reference

1. Federal Committees
2. Provincial Committees
3. Private Organizations

CANADIAN ASSOCIATION OF PESTICIDE CONTROL OFFICIALS. (C.A.P.C.O.)

AUTHORIZATION: Minister of Agriculture for Canada with concurrence of provincial ministers.

PURPOSE: This is an association of Federal and Provincial government officials responsible for the regulation of pest control products in Canada. It provides for the exchange of technical and regulatory information, the cooperative study and resolution of regulatory problems, identification of information deficiencies which require research and investigatory programs, provision of guidelines for consistent regulation amongst the agencies and the identification of the need for new or revised legislation to cope with changing conditions in the marketing and use of pest control products.

MEMBERSHIP: CHAIRMAN: J.B. Gurba, Head, Crop Protection & Pest Control Branch, Alberta Agriculture, Edmonton (1975)

SECRETARY: J.A. Scott, Control Products Section, Agriculture Canada, Ottawa (continuing)

Members are official representatives of agencies charged by federal or provincial laws to regulate and manage pesticides- 2 members from each province and 2 members from each of the federal Departments of Agriculture, Health & Welfare and Environment (Alberta representative: J.B. Gurba and L.K. Peterson, Alberta Environment).

Ad hoc committee 1971, established as permanent committee in fall, 1973. Meets twice annually at present.

CANADA COMMITTEE ON PESTICIDE USE IN AGRICULTURE - *(NCPUA - 1961 - 69)*
(CCPUA - 1970 -)

AUTHORIZATION: Canadian Agricultural Services Coordinating Committee, C.D.A.

PURPOSE: To define problems in crop and animal protection and to co-ordinate and stimulate research by all the Canadian agencies with an interest in the field of livestock, fruit, vegetables, cereal and forage protection through the use of pesticides.

To summarize, interpret and make available current information on crop and animal protection materials, methods, and domestic and foreign regulations that have a bearing on their use.

To promote agreement on a set of uniform principles and criteria to be employed in drafting local recommendations for pesticide use.

MEMBERSHIP: CHAIRMAN: Dr. H.V. Morley, Coordinator, Environment & Resources, C.D.A., Ottawa

SECRETARY: Dr. N.J. Bostanian, Scientific Information Officer, C.D.A.

J.B. Gurba, Head, Crop Protection & Pest Control, A.D.A.

Representatives from:

Dept. of Agriculture, Gov't of Canada
B.C. Dept. of Agriculture
University of Guelph
Nova Scotia Agriculture
Ontario Dept. of Agriculture
New Brunswick Agriculture
Saskatchewan Dept. of Agriculture
Manitoba Dept. of Agriculture
Quebec Dept. of Agriculture
Dept. of National Health & Welfare, Gov't of Canada
Canadian Agricultural Chemicals Association
Western Veterinary College, U of S, Saskatoon
Department of Environment, Gov't of Canada

Permanent committee; meets annually, reports to CASCC

WESTERN COMMITTEE ON CROP PESTS (W.C.C.P.)

AUTHORIATION: Established as a regional committee under CCPUA (Canada Committee on Pesticide Use in Agriculture) by Agriculture Canada in 1963.

PURPOSE: To provide a scientific basis for pesticide recommendations for crop pests.

Review research and define research required.

Stimulate cooperation and coordination regionally.

Provide a guide on insecticide recommendations for crop pests that can be used to develop provincial recommendations.

MEMBERSHIP: CHAIRMAN: Dr. R.H. Burrage, Head, Entomology Section
Agriculture Canada, Research Station,
Saskatoon, (1976)

SECRETARY: Mr. M.F. Taylor, Information Officer, Agriculture
Canada, Research Station, Saskatoon (1976)

Mr. M.G. Dolinski, Supervisor, Entomology, ADA, Edmonton
Mr. J.B. Gurba, Head Crop Protection & Pest Control,
ADA, Edmonton
Mr. L.K. Peterson, Head, Pesticide Chemicals Branch,
Alberta Environment, Milner Bldg., Edmonton
Mr. H.G. Philip, Head, Entomology Section, Plant Industry
Lab, ADA, Edmonton

Executive changes annually depending on the site of the meeting, e.g. Victoria, Lethbridge, Saskatoon or Winnipeg Research Stations. Other members represent provincial departments of agriculture and federal agriculture, forestry, health and wildlife and the pesticide industry.

Permanent committee; meets annually; reports to CCPUA

WESTERN COMMITTEE ON LIVESTOCK PESTS (W.C.L.P.)

AUTHORIZATION: Established as a regional committee under CCPUA (Canada Committee on Pesticide Use in Agriculture) by Agriculture Canada with cooperation of Alberta, B.C., Saskatchewan and Manitoba departments of agriculture in 1959.

PURPOSE: To provide a scientific basis for pesticide recommendations.

Review research and define research required.

Stimulate cooperation and coordination regionally.

Provide a guide on livestock pesticide recommendations that can be used to develop provincial recommendations.

MEMBERSHIP: CHAIRMAN: Mr. J. Weintraub, Entomologist,
Veterinary-Medical Entomology Section
CDA Research Station, Lethbridge

SECRETARY: Dr. M.A. Khan, Toxicologist,
Veterinary-Medical Entomology Section
CDA Research Station, Lethbridge

Dr. W.O. Haufe, Head, Veterinary-Medical Entomology Section, CDA Research Station, Lethbridge
Dr. G.S. Cooper, Canadian Agricultural Chemicals Association, Plaza One - 2000 Argentia Road, Mississauga, Ontario
Dr. C.S. Sisodia, Western College of Veterinary Medicine, University of Saskatchewan, Saskatoon, Saskatchewan
A.J. Kolach, Manitoba Dept. of Agriculture, 715 Norquay Bldg., Winnipeg, Manitoba
Dr. S.E. Magwood, Animal Diseases Research Institue (Western) Box 640, Lethbridge
C.L. Neilson, Provincial Entomologist, B.C. Dept. of Agriculture Victoria, B.C.
Dr. J.R. Jowsey, Pest and Predator Control Specialist, Government Administration Building, Saskatchewan Dept. of Agriculture, Regina, Saskatchewan
Mr. F.J.H. Fredeen, Research Station, Agriculture Canada, Saskatoon, Saskatchewan
J.B. Gurba, Alberta Agriculture, Agriculture Bldg., Edmonton
L.K. Peterson, Pesticide Chemicals Branch, Alberta Environment Milner Building, Edmonton
D.L. Smith, Manitoba Dept. of Agriculture, Norquay Bldg., Winnipeg, Manitoba
Mrs. Janet K. Taylor, Control Products Section, Production & Marketing Branch, Agriculture Canada, Ottawa

Permanent committee; meets annually; reports to CCPUA

ALBERTA INTERDEPARTMENTAL COMMITTEE ON PESTICIDES (A.I.C.P.)

AUTHORIZATION: Minister of Agriculture, 1966 with cooperation of Ministers of Health, and Lands and Forests (Environment added 1971)

PURPOSE: To continually review the field of pesticides, development application, new products, danger to health. etc.

To recommend to government, controls at federal and provincial levels to regulate the use of pesticides.

To study inter-departmental relationships and responsibilities in such areas as licensing of operators, health standards, training and education of personnel and public.

To adivse on general terms of controls, and specific regulations on chemicals.

MEMBERSHIP: CHAIRMAN: Dr. W.P. Skoropad, Head, Plant Pathology, U of A

SECRETARY: Mr. J.B. Gurba, Head, Crop Protection & Pest Control, ADA, Edmonton

Dr. N.D. Holmes, Head, Entomology Section, Agriculture Canada Research Station, Lethbridge
Dr. W. Watt, Director, Local Health Services, Dept. of Health & Social Development, Administration Building, Edmonton
Dr. H. Buchwald, Director, Industrial Health Services, Alberta Labor, Edmonton
Dr. H.N. Vance, Director, Veterinary Services, ADA, Edmonton
Mr. R.P. Dixon, Product Development Commissioner, Marketing Division, ADA, Edmonton
Dr. A.O. Olson, Director, Plant Industry Division, ADA, Edmonton
Mr. D.J. Neave, Fish & Wildlife Division, Alberta Recreation, Parks & Wildlife
Dr. Drake Hocking, Canadian Wildlife Service, Environment Canada, Edmonton
Dr. G.E. Ball, Head, Entomology Department, U of A, Edmonton
Dr. W.G. Corns, Plant Science Department, U of A, Edmonton
Mr. W.D. Charles, Health Protection Branch, Dept. of National Health & Welfare, Room 30, Commonwealth Bldg., Edmonton
Mr. E.R. Heinrichs, Coordinator, Regulated Commodities, Agriculture Canada, Federal Building, Edmonton
Mr. E.E. Kupchanko, Assistant Deputy Minister, Alberta Environment, Milner Building, Edmonton
Mr. L.K. Peterson, Head, Pesticide Chemicals Branch, Alberta Environment, Milner Building, Edmonton
Dr. R. Edwards, Environmental Protection Service, Environment Canada, Edmonton

Permanent committee; meets annually or at call of Chairman

PEST CONTROL ADVISORY COMMITTEE (P.C.A.C.)

AUTHORIZATION: Alberta Agricultural Co-ordinating Committee, 1966. Advisory to the Crop Production Board, 1957.

PURPOSE: To review and examine research on insect pests. plant diseases and destructive animals as related to agriculture.

To advise the Dept. of Agriculture on developments as they may affect department policies and farm practices.

To revise and up-date information and recommendations on pest control techniques including the use of pesticides.

MEMBERSHIP: CHAIRMAN: Dr. W.P. Skoropad, Head, Plant Pathology, U of A

SECRETARY: J.B. Gurba, Head, Crop Protection & Pest Control, A.D.A.

Dr. B. Heming, Entomology Dept, U of A
Dr. W.O. Haufe, Veterinary-Medical Entomology, C.D.A., Lethbridge
Dr. M.A. Khan, Veterinary-Medical Entomology, C.D.A., Lethbridge
Dr. N.D. Holmes, Head, Entomology Section, C.D.A., Lethbridge
S. McDonald, Toxicologist, C.D.A. Research Station, Lethbridge
Dr. J.B. Lebeau, Pathology, Research Station, Lethbridge
Dr. F.R. Harper, Pathology, C.D.A. Research Station, Lethbridge
Mr. P.E. Blakely, Technical Liaison Officer, C.D.A., Lethbridge
Dr. L.J. Piening, Platn Pathology, C.D.A. Research Stn., Lacombe
Mr. E.R. Heinrichs, Plant Products Div., C.D.A., Federal Bldg.
Mr. R.P. Brandrith, Plant Protection Div., C.D.A. Federal Bldg.
Dr. B. Bolwyn, Head, Plant Industry Lab., A.D.A. Edmonton
Dr. J.S. Horricks, Supervisor, Plant Pathology, A.D.A.
Mr. M.G. Dolinski, Supervisor, Entomology, A.D.A.
Mr. C.F. Barrett, Supervisor, Animal Pest Control, A.D.A.
Mr. L.K. Peterson, Head, Pesticide Chemicals, Dept. of Environment
Mr. V. Patterson, Canadian Forestry Service, 5320 - 122 St.
Dr. H.F. Cerezke, Canadian Forestry Service, 5320 - 122 St.
Dr. D. Hocking, Canadian Wildlife Service, 10015 - 103 Ave.
Mr. W.D. Charles, Health Protection, National Health & Welfare
Room 30, Commonwealth Building, 9912 - 106 Street, Edmonton
Dr. H. Buchwald, Director, Division of Industiral Health Services,
Dept. of Health & Social Development, 10523 - 100 Ave.
Mr. D.J. NEAVE, Chief Wildlife Biologist, Fish & Wildlife Div.
Dept. of Lands and Forests, Edmonton

Permanent committee; meets annually; reports to A.A.C.C.

AGRICULTURAL CHEMICALS ADVISORY COMMITTEE (A.C.A.C.)

AUTHORIZATION: Section II Agricultural Chemicals Act. Committee appointed by Order-In-Council 1970. Transferred from ADA to Alberta Environment, October 1971.

PURPOSE: To serve as an advisory body on all aspects relating to the Agricultural Chemicals Act and its regulations. To advise the Minister on the Act and make recommendations on appeals.

1976 MEMBERSHIP: CHAIRMAN: J.B. Gurba, Head, Crop Protection & Pest Control Alberta Agriculture, Edmonton

SECRETARY: W.Lobay, Head, Weed Control & Field Services, Alberta Agriculture, Edmonton

D.J. Neave, Fish & Wildlife Division, Alberta Parks, Recreation & Wildlife, Natural Resources Bldg., Edmonton
D.E. Gibson, Director, Occupational Hygiene Branch, Occupational Health & Safety Division, Alberta Labor, Edmonton
J. Donald McKenzie, Marketing Representative, Gulf Agricultural Chemicals Ltd., Calgary
Ross M. Stetson, Standards & Approvals Division, Industrial Wastes Branch, Alberta Environment, Milner Bldg., Edmonton
L.M. Miller, Reeve, Country of Parkland, Stony Plain
L.K. Peterson (ex officio) Head, Pesticide Chemicals Branch, Alberta Environment, Milner Bldg., Edmonton

Committee meets 3 - 4 times a year

Committee permanent subject to change of personnel by O/C

ALBERTA BLACKFLY COORDINATING COMMITTEE (A.B.C.C.)

AUTHORIZATION: By agreement of institutions concerned, with approval of the Department of Agriculture. Various ad hoc committees have met since 1964, forming the present committee established in the spring of 1973.

PURPOSE: To reduce the serious effect of blackflies on livestock production and recreational activities in the Athabasca region and northern areas through coordinated inter-agency research.

To survey and investigate blackfly and other biting fly breeding areas and populations and assess the feasibility of formulating biological and chemical controls for this pest.

1976 MEMBERSHIP: CHAIRMAN: L.K. Peterson, Head, Pesticide Chemical Br.
Alberta Environment, Milner Building

SECRETARY: H.G. Philip, Head, Entomology Section,
Plant Industry Laboratory, ADA

B.W. Taylor, Section Head, Pesticide Chemical Branch, Albert Environment, Milner Building
J.B. Gurba, Head, Crop Protection & Pest Control, Alberta Agriculture
Dr. B.E. Beck, Veterinarian, Laboratory Services Branch, Veterinary Services Division, Alberta Agriculture
K.J. Spiller, Livestock Supervisor, Animal Industry Division, Alberta Agriculture
D. Buchwald, Parks, Recreation and Wildlife, Edmonton
S. Zayezierski, A.S.B., County of Athabasca, Athabasca
G. Berger, D. Ag., County of Athabasca, Athabasca
F.P. Appleby, Member of Legislative Assembly, County of Athabasca, Athabasca
Dr. W.O. Haufe, Head, Veterinary Medical Entomology, Agriculture Canada, Lethbridge
Dr. K.R. Depner, Research Scientist, Agriculture Canada, Lethbridge
Dr. W.L. Lockhart, Fisheries & Marine Service, Environment Canada, Winnipeg
J. Flannagan, Fisheries & Marine Service, Environment Canada, Winnipeg
Dr. D.A. Craig, Dept. of Entomology, U of A, Edmonton
Spyros Beltaos, Highway & River Engineering, Alberta Research Council, Edmonton

Permanent committee; meets annually; task forces meet as necessary in development of research program.

PROBLEM WILDLIFE COMMITTEE

AUTHORIZATION: An action or operational committee established in 1974 by agreement of the Ministers of Agriculture and Lands and Forests.

PURPOSE: To consider current problems in vertebrate wildlife management and provide a team approach in planning and action.

To review the management of problem wildlife with the object of assessing adequacy of programs, identifying needs, demands and conflicts of interest, and developing solutions. Advising on joint programs and efficient use of personnel and resources. Interagency exchange of information to the public.

To provide a public forum on policies and programs.

To form working parties or subcommittees as required to study or handle special problems.

To meet at least once a year and to report with recommendations to the Ministers of Agriculture, and Recreation, Parks and Wildlife.

1976 MEMBERSHIP: CHAIRMAN: D.J. Neave, Chief Wildlife Biologist,
Fish and Wildlife Division,
Alberta Parks, Recreation & Wildlife

SECRETARY: Dr. M.J. Dorrance, Head, Zoology Section,
Plant Industry Laboratory, Alberta Agriculture

J.B. Gurba, Head, Crop Protection & Pest Control,
Alberta Agriculture (Vice-Chairman)
C.F. Barrett, Supervisor, Animal Pest Control,
Alberta Agriculture
(vacant) Field Supervisor, Rabies Vector Control,
Alberta Agriculture
J. Bourne, Field Supervisor, Predator Damage Control,
Alberta Agriculture
G.A. Kemp, Senior Wildlife Management Biologist,
Fish & Wildlife Division, Alberta Recreation, Parks & Wildlife
B.V. Sigurdson, Problem Wildlife Co-ordinator, Fish & Wildlife
Division, Alberta Recreation, Parks & Wildlife
E.J. Psikla, Branch Head, Field Services & Enforcement,
Fish & Wildlife Division, Alberta Recreation, Parks & Wildlife
J.R. Gunson, Supervisor, Problem Wildlife, Fish & Wildlife
Division, Alberta Recreation, Parks & Wildlife

ALBERTA AGRICULTURAL COORDINATING COMMITTEE

I. Function

The Alberta Agricultural Coordinating Committee (AACC) as established by the Minister of Agriculture, Government of Alberta and as a subcommittee of the Canadian Agricultural Services Coordinating Committee (CASCC), shall:

1. provide a forum for discussion of policy and program areas of interest to Alberta agriculture,
2. on matters related to agriculture program and policies, advise the Alberta Minister of Agriculture and, where necessary, through him advise the Federal Minister of Agriculture, Presidents of Universities and other agencies,
3. keep under regular review the broad aspects of agricultural research, extension and education in Alberta with the object of:
    a. facilitating inter-group communication and coordination of management levels,

    b. assessing immediate and future needs and developing proposals to meet them,

    c. advising on joint uses of available facilities and personnel,

    d. contributing information and ideas bearing on regional and national policies affecting agriculture,

    e. carry out special assignments on behalf of CASCC appropriate to the above objectives.

II. Membership

1. Membership of AACC shall consist of:
    a. the Deputy Minister, Alberta Agriculture (Chairman),

    b. two persons including the Dean from the Faculty of Agriculture and Forestry, University of Alberta, Edmonton,

    c. three Directors from Agriculture Canada Research Stations -- Lethbridge, Lacombe, and Beaverlodge,

    d. three Assistant Deputy Ministers, Alberta Agriculture -- Production, Marketing and Development,

    e. the Secretary -- ex officio,

    f. a quorum shall consist of three voting members representing each of CDA, University and ADA.

III. Formation of Advisory Committees

1. AACC may establish Advisory Committees
2. Wherever possible Advisory Committees shall be structured on a commodity or subject matter basis

3. a. Advisory Committees may establish their own membership, however, AACC reserves the option for final ratification.

   b. To avoid unwieldiness, where possible, membership should be limited to one representative from each agency involved.

   c. Advisory Committees are encouraged to include members representing farm organizations and agribusiness.

   d. Each Advisory Committee shall establish its own executive, consisting of a chairman, vice chairman and secretary. To facilitate coordination it is preferable that the secretary be from Alberta Agriculture.

4, Advisory Committees may form subcommittees as are necessary for their operation. The executive of each subcommittee should consist of members of the Advisory Committee, however, other members of the subcommittee may be nominated from outside the Advisory Committee.

WESTERN COMMITTEE ON PLANT DISEASE CONTROL

AUTHORIZATION: Ad hoc committee commenced 1975; Supported in principle by Pest Control Advisory Committee and Alberta Agricultural Coordinating Committee.

PURPOSE: To increase the effectiveness of those responsible for solving practical plant disease control problems by sharing the expertise and experience of the extension and research pathologists within the region.

To compile a set of well-documented measures for the control of the important plant diseases in western Canada to serve as a basis for provincial recommendations.

To provide a means for regularly reviewing control measures so that information on new disease control products, resistant varieties, or other control measures can be evaluated and rapidly and effectively incorporated into disease control recommendations.

To identify disease control measures that need to be developed or require further research or evaluation and to arrange for the necessary studies to be carried out.

To alert plant pathologists in the region of new disease situations that are of common conern so that coordinated control measures can be taken.

1976 MEMBERSHIP: CHAIRMAN: Dr. T.G. Atkinson, Plant Pathology
Agriculture Canada, Lethbridge

A/SECRETARY: Dr. F.R. Harper, Plant Pathology
Agriculture Canada, Lethbridge

Dr. J.S. Horricks, Supervisor, Plant Pathology, ADA Edmonton plus other western provincial platn pathologists

DURATION: ad hoc committee with first full meeting scheduled for February 19, 1976

AQUATIC PLANT MANAGEMENT COMMITTEE

TERMS OF REFERENCE

1) To serve as an advisory committee acting in a technical and administrative capacity on aquatic vegetation management problems.

2) To approve and administer aquatic vegetation management programs under the direction of the Ministers of Agriculture, Environment, Recreation, Parks and Wildlife; including members of the three departments, University of Alberta, Agriculture Canada and the Canadian Agricultural Chemicals Association.

3) To name the herbicides and their respective concentrations which may be applied to water.

4) To advise the various departments and agencies and the Canadian Agricultural Chemicals Association and other related industries regarding amendments to existing legislation and the need for new legislation in the field of aquatic vegetation management.

5) To advise on the legislation and regulations relating to the application of herbicides to shores, banks and semi-aquatic areas.

6) To maintain liaison with the Canada Weed Committee with regard to the efficacy of various chemicals for aquatic vegetation management and any other committee which has direct or indirect interest in vegetation management and water quality such as the Alberta Interdepartmental Committee on Pesticides and the Agricultural Chemicals Advisory Committee

7) To review and advise on the various fields of research and special investigations that may be required and direct implementation to appropriate agency.

8) To provide relevant information to the general public.

9) To advise on the legislation and regulations relating to the application of herbicides to shores, banks and semi-aquatic areas.

The Canadian Agricultural Chemicals Association and its Provincial Councils

The Canadian Agricultural Chemicals Association was formed in 1952 and is the national organization of those companies engaged in the manufacture, formulation and distribution of agricultural pesticides in Canada.

The members of the association and a list of its Officers and Directors for 1974-75 are attached to this submission.

In Alberta, as in most of the Canadian provinces, there is a Provincial Council of the Canadian Agricultural Chemicals Association.

The function of each provincial council is to provide the closest possible liaison between the industry and concerned authorities both public and private in each province.

In Alberta this involves liaison with appropriate ministries and officials of the provincial government together with information sharing, professional counsil and problem researching in cooperation with these government ministries and officials and with agricultural producers, those in the teaching professions and those concerned with human and animal health and environment protection.

Each provincial council operates within the framework of the bylaws of Canadian Agricultural Chemicals Association.

Purpose

The purpose of the Canadian Agricultural Chemicals Association is to promote, in a manner consistent with the public interest, the development of the pest control chemicals industry in Canada so that it may adequately serve agriculture in Canada. This involves undertakings in cooperation with all levels of government, and with other organizations and agencies whose activities are in any way connected with the industry, to bring about improvements in agricultural production and pest borne disease control designed to maintain a high standard of public health and while so doing to protect natural resources and to ensure safety and environmental quality.

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PERSONAL COMMUNICATIONS

Block, H. District Resource Officer, Water Quality Br., Inland Waters Directorate, Calgary.

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Forbes, M. Western Region Water Quality Br., Inland Waters Directorate, Calgary.

Gurba, J. Head, Crop Protection & Pest Control Branch, Alberta Agriculture.

Mangat, R., Prov. Parks Division, Dept. of Rec., Parks and Wildlife.

Muldrew, J. Environment Canada, Northern Forest Research Centre, Edmonton.

Patterson, J. Canadian Wildlife Service, Saskatoon.

Philip, H., Head, Entomology Section, Plant Industry Lab., Alberta Agriculture.

Rogers, G. Parks Canada, Calgary.

van Borstel, R.C. Chairman, Dept. of Genetics, Univ. of Alberta and representative of Environmental Mutagen Society to E.C.A. Public Hearings into Use of Pesticides.